VOLUME LV NUMBER 7 WHOLE 486

SCHOOL SCIENCE AND MATHEMATICS

OCTOBER 1955

and Mathematics

School Science and Mathematics

A Journal for All Science and Mathematics Teachers

All matter for publication, including books for review, should be addressed to the editor. Payments and all matter relating to subscriptions, change of address, etc. should be sent to the business manager.

Entered as second class matter December 8, 1932, at Menasha, Wisconsin, under the Act of March 3, 1879. Published Monthly except July, August and September at 450 Ahnaip St., Menasha, Wis. PRICE. Four dollars and fifty cents a year; foreign countries $5.00; current single copies 75 cents.

Contents of previous issues may be found in the Educational Index to Periodicals.

Copyright 1955, by the Central Association of Science and Mathematics Teachers, Inc.
Printed in the United States of America

GLEN W. WARNER
Editor
Lakeville, Indiana

GEORGE G. MALLINSON
Assistant Editor
Kalamazoo, Michigan

RAY C. SOLIDAY
Business Manager
Box 408, Oak Park, Ill.

DEPARTMENTAL EDITORS

BIOLOGY—Paul E. Kambly
University of Oregon, Eugene, Ore.
Joseph P. McMenamin
Oak Park-River Forest High School, Oak Park, Ill.
Nelson L. Lowry
Arlington Heights High School, Arlington Heights, Ill.

CHEMISTRY—Gerald Osborn
Western Michigan College, Kalamazoo, Mich.

ELEMENTARY SCIENCE—Milton O. Pella
The University of Wisconsin, Madison, Wis.

GENERAL SCIENCE—John D. Woolever
Mumford High School, Detroit, Mich.

GEOGRAPHY—Villa B. Smith
John Jay High School, Cleveland, Ohio

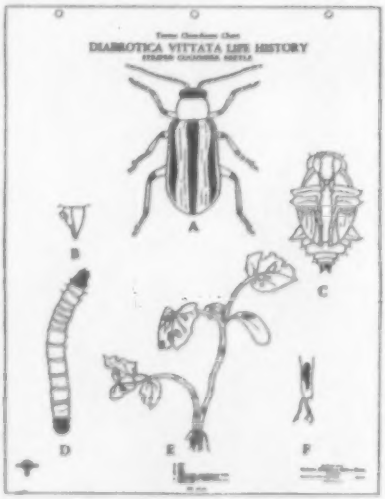
MATHEMATICS—Cecil B. Read
University of Wichita, Wichita, Kan.
George E. Hawkins
Lyons Twp. High School and Junior College, La Grange, Ill.

MATHEMATICS PROBLEMS—Margaret F. Willerding
Harris Teachers College, St. Louis, Mo.

NATURE STUDY—E. Laurence Palmer
Cornell University, Ithaca, N.Y. and The American Nature Association.

PHYSICAL SCIENCE—B. Clifford Hendricks
457 24th Avenue, Longview, Wash.

PHYSICS—E. Wayne Gross
R.R. 6, Bloomington, Ind.



Turtox Charts

The original biological drawings published as Turtox Charts, Key Cards and Quiz Sheets offer you a selection of more than 350 subjects.

For a handy reference pricelist of these subjects write for the free *Turtox Three-Way Checklist.*

TURTOX PRODUCTS

GENERAL BIOLOGICAL SUPPLY HOUSE
Incorporated
8200 SOUTH HOYNE AVENUE
CHICAGO 20, ILLINOIS
The Sign of the Turtox Pledges Absolute Satisfaction

Outstanding Heath Texts—

A First Course in Algebra,
2nd Edition

A Second Course in Algebra,
2nd Edition, Enlarged

W. W. Hart

Each of these texts offers a complete, compact course. Extra materials, clearly marked, give scope to superior students. The series features effective motivation material and non-technical language. *Teacher's Manuals.*

Plane Geometry

W. W. Hart

This teachable text contains carefully graded and selected exercises, helpful reviews, mastery tests, and drill on arithmetic skills. *Teacher's Manual.*

Solid Geometry

W. W. Hart and V. Schult

A clear, logical presentation, interesting motivation pages, a functional format and helpful diagrams make this book a real study aid. *Teacher's Manual.*

D. C. HEATH AND COMPANY

Publishers of better books for better teaching

Sales Offices: New York 14 Chicago 16 San Francisco 5
Atlanta 3 Dallas 1 *Home Office:* Boston 16

Clear-cut teaching-and-learning programs adapted to today's classroom needs . . .

ALGEBRA for Problem Solving

BOOKS ONE AND TWO

FREILICH BERMAN JOHNSON

Here is a *complete* course in high school algebra with clear-cut organization, abundant exercises and problems, and tests, reviews, and summaries for every chapter. It is an unusually sound program that teaches for understanding as well as for use. Special features include really effective use of a second color, emphasis on solving problems in realistic situations, and "Extras for Experts."

MAKING MATHEMATICS WORK

NELSON GRIME

This general mathematics text presents high school students with important, real problems for which mathematical skills are vital. Buying on credit, budgeting the household expenses, making investments, and using checking accounts are only a few of the everyday problems through which students are given a comprehensive review of arithmetic, a reteaching of fundamental processes, and an introduction to statistics, practical geometry, and algebra.

Houghton Mifflin Company

Boston New York Chicago Dallas Atlanta Palo Alto

October turned my maple's leaves to gold;
The most are gone now; here and there one lingers;
Soon these will slip from out the twig's weak hold,
Like coins between a dying miser's fingers.
—T. B. ALDRICH. "Maple Leaves."

CONTENTS FOR OCTOBER, 1955

Grainless Farms—*B. Clifford Hendricks* 505

The 55th Annual Convention—*Milton O. Pella, President* 508

"Endless Numbers" (Repetends)—*Donald V. Mitchell* 509

Bernard Clifford Hendricks, Editor for Science—*Glen W. Warner* 516

A Classroom Window Weather Station—*Glenn F. Powers and Will S. De Loach* 517

Mathematics and Money—*J. E. Slaughter* 518

The Decimal Point in Slide Rule Calculations—*Don L. Lewis* 520

An Improved and Convenient Apparatus for Burning Phosphorous in a Volume of Air—*Mennow M. Gunkle* 521

Dinosaurs Yesterday—Petroleum Today—*James K. Anthony* 525

Mathematical Thought for the Morrow—*Lester H. Lange* 529

Experimental Study on the Teaching of Scientific Thinking in a Physical Science Course at the College Level—*Rogers E. Randall* 535

Training Men for Industry—*John Sieger* 540

Proof in Addition by Lateral Addition—*Vally L. Johnson* 544

The Science Fair in Minnesota—*Leonard A. Ford* 545

Physics or the Misuse of Mathematics—*William H. Dannacher* 548

A Style Form Guide for Typewritten Mathematical Manuscripts—*Cecil B. Read* 550

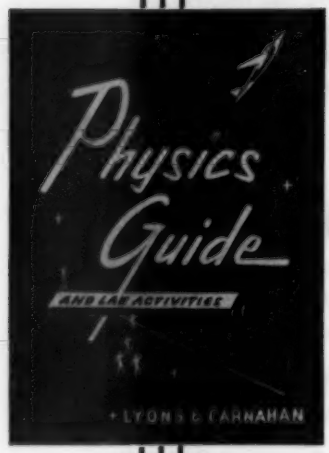
Proposed Amendments to the By-Laws of the Central Association of Science and Mathematics Teachers 563

Problem Department—*Margaret F. Willerding* 565

Books and Pamphlets Received 572

Book Reviews 576

NEW Edition of an old favorite!



— a study guide

— a practice guide

— a review program

— an objective testing program for use with any textbook

— a Lab Manual, but much MORE than a Lab Manual

By IRA C. DAVIS and CLIFFORD HOLLEY

LYONS and CARNAHAN

CHICAGO, ILL. **WILKES-BARRE, PA.**

Atlanta **Dallas** **Pasadena** **Portland**

When the SCIENCE OF MATHEMATICS is presented in its true character—AS PURE SCIENCE—instead of as an academic tradition, the saving in Time, Energy, and "Man-Power" is enormous.

This approach—a war-stress product—clearly shows the scientific character of Correct, Mathematical Thinking—wherein everything is in order, perfectly related to everything else in the Realm of Mathematics, operating with EASE, SPEED, and ACCURACY—and automatically precluding anything awkward, difficult, or involved. New areas for original research are revealed.

Since the properties of "factual" (scientific) thinking are not considered in modern educational psychology this development is new to mathematics literature. It is designed to produce expert computers at all elementary levels—Addition to Solid Trigonometry—quickly, by giving training in the latest types of computing aids and methods, such as: The new table of Decimal Equivalents (½ to 99/100) used for solving division-type problems by direct readings. Slide Rule the "fast" (scientific) way—not in other texts, etc. etc. And on to 6-place Logarithmic and Trigonometric precision computing.

Many topics are DELIGHTFUL for lower-grade levels when "pre-digested" and fed in for enrichment, such as: Disappearing Nines, Start-left Addition, Doubling and Halving, Cross-Multiplication, Shortened Long-Division, Table Computing, Repetends, Continued Fractions, etc.

"TAKE THE STING OUT OF MATHEMATICS" or MATH. AS YOU LIKE IT, (1953)

—A complete pre-engineering course—Elementary Arithmetic to Solid Trigonometry. 125-pages, stiff paper. 14 x 21.5 cm. Postpaid $2.50, or $3.00 with SIX-PLACE (Log. and Trig.) TABLES.

SIX-PLACE TABLES FOR PRECISION COMPUTING, (1945)—47 pages, Postpaid $1.00.

Contains: 6-place Logarithms of Numbers; 6-place Trigonometric Functions (on .1° intervals) with all six Natural Functions on a facing page with their Logarithmic Equivalents (—not published elsewhere) with table differences shown throughout; Decimal Equivalents 1/2 to 99/100; and the usual Powers and Roots Tables.

Examine 30 days. Order on approval. Full refund if not 100% desired.

Author-Publisher DONALD V. MITCHELL, 12345 Sand Point Way, Seattle 55, Washington

NOTE: This coverage and "fast operating" table equipment was prepared to fit the exacting training program of the Armed Forces—the USAFI, the U.S. Air Force Academy, the Marine Air Training Station—and the Boeing Technical Training Program (Seattle) where it had its inception and early development. Suitable for advanced Technical H. S., Junior College, Engineering Schools—and as a basic course in PURE SCIENCE in Teacher Training Institutions.

Have You Seen the 1955-56 Edition of the CamboscO Order Book?

If not, a complimentary copy is yours for the asking.

You'll find it a helpful guide whenever you need apparatus, reagents or specimens, for Chemistry, Physics or Biology.

Your copy will be mailed, postpaid, immediately on receipt of your teaching address.

CamboscO SCIENTIFIC COMPANY

37 ANTWERP STREET, BRIGHTON STATION

BOSTON, MASS., U.S.A.

School Science and Mathematics

—a journal devoted to the improvement of teaching of the sciences and mathematics at all grade levels.
—nine issues per year, reaching readers during each of the usual school months, September through May.
—owned by The Central Association of Science and Mathematics Teachers, Inc., edited and managed by teachers.

SUBSCRIPTIONS—$4.50 per year, nine issues, school year or calendar year. Foreign $5.00. No numbers published for July, August, September.
BACK NUMBERS—available for purchase, more recent issues 75¢ per copy prepaid with order. Write for prices on complete annual volumes or sets. Consult annual index in December issues, or Educational Index to Periodicals, for listings of articles.
The following interesting topics are discussed in issues of 1954:
Geometry of Paper Folding—Mathematical Figures—The Digital Computer, a Challenge to Mathematics Teachers—Rainmaking; a Contemporary Science Problem—Magnetism: Electromagnets, Present Day Conceptions of the Elementary Magnet, Ferromagnetic Bodies—Recreational Mathematics for the Mathematics Classrooms of Our Secondary Schools—New Books for High School Science Shelf—Standard Equipment for General Science—Synthetic Detergents.

USEFUL REPRINTS—(orders for reprints must be prepaid)

Atomic Energy: A Science Assembly Lecture, Illustrated	.25
Mock Trial of B versus A—A play for the Mathematics Club	.30
How Much? A Mathematics Playlet	.25
100 Topics in Mathematics—for Programs or Recreation	.25
Poison War Gases	.20
New Emphases in Mathematical Education, with bibliographies	.25
Popular Mathematics: Bibliography	.20
Mathematics Problems From Atomic Science	.25
The Mathematics of Gambling	.25
Optical Illusions: for high school mathematics	.25
Computations With Approximate Numbers	.25
The Radical Dream—A Mathematical Play for Puppets	.20
Geometry Theorems: A List of Fundamentals	.20
How Water Serves Man. A teaching unit	.20
Biology Reading List	.20
Won by a Nose. A Chemistry play	.25
Radioactive Isotopes: A Science Assembly Lecture, illustrated	.25
Kem: Two Games for Chemistry Classes	.15
Modern Periodic Arrangements of the Elements; illustrated	.25
Ion Visits the Realm of Air. A Play	.25
The King of Plants. A play for science clubs	.25
Three Families of Great Scientists: dramatized	.30
Some Lessons About Bees. A 32-page booklet; illustrated	.20
The Triumph of Science. A play for auditorium programs	.25
In a Sound Studio. A play: Physics and Music	.25
In Quest of Truth. A play in two parts	.25
A Student's Approach to Mechanics	.25
Youth Looks at Cancer. A biology play	.25
Apparatus for Demonstrating the Fundamentals of Radio	.20
Youth Opens the Door to Cancer Control, bibliographies	.25
Science in the Grades: Practical Contributions—35 pp.	.30
Extracting Aluminum. A one act chemistry play	.15
Vitalizing Chemistry Teaching. A Unit on the Halogens	.15
Telescope Making Illustrated	.25
A Scientific Assembly Program, Wonders of Science	.30
What Is Scientific Method?	.20
Elementary School Science Library	.20
Projection Demonstrations in General Science	.20
Atomic Energy—A Play in Three Scenes	.30
Motion Pictures for Elementary Science	.25

SCHOOL SCIENCE AND MATHEMATICS

Price $4.50—Foreign $5.00

P.O. Box 408 Oak Park, Ill.

CENTRAL ASSOCIATION OF SCIENCE AND MATHEMATICS TEACHERS
OFFICERS FOR 1955

President: Milton O. Pella, University of Wisconsin, Madison, Wis.

Vice President: Charlotte W. Junge, Wayne University, Detroit, Mich.

Secretary-Historian: Virginia Terhune, Proviso Township High School, Maywood, Illinois

Treasurer-Business Manager: Ray C. Soliday, Oak Park High School, Oak Park, Illinois

EXECUTIVE COMMITTEE FOR 1955

Milton O. Pella, President
Charlotte W. Junge, Vice President
H. Vernon Price, President for 1954

BOARD OF DIRECTORS FOR 1955

Ex-Officio

Milton O. Pella, President
Charlotte W. Junge, Vice President
H. Vernon Price, President, 1954, University High School, Iowa State University, Iowa City, Iowa

Terms Expire in 1955

Edward Bos, Proviso Township High School, Maywood, Ill.
John E. Habat, Euclid Shore Junior High School, Euclid, Ohio
James H. Otto, Washington High School, Indianapolis, Ind.
Iva Spangler, Central High School, Fort Wayne, Ind.

Terms Expires in 1956

William Herbert Edwards, Central High School, Detroit, Mich.
Jacqueline Buck Mallinson, Kalamazoo, Mich.
Louis Panush, Northeastern High School, Detroit, Mich.
Reino Takala, Hinsdale High School, Hinsdale, Ill.

Terms Expire in 1957

E. Wayne Gross, Laboratory School, Indiana University, Bloomington, Ind.
Ralph C. Huffer, Beloit College, Beloit, Wis.
Clyde T. McCormick, Illinois State Normal University, Normal, Ill.
Willard D. Unsicker, University High School, Iowa State University, Iowa City, Iowa

EDITOR OF THE YEARBOOK

Luther Shetler, Bluffton College, Bluffton Ohio

JOURNAL OFFICERS

Glen W. Warner, Editor, Lakeville, Ind
George G. Mallinson, Assistant Editor, Western Michigan College of Education, Kalamazoo, Mich.

SECTION OFFICERS FOR 1955

(Order: Chairman, Vice Chairman Secretary)

Biology

Hubert L. Edquist, Riverside-Brookfield High School, Riverside, Ill.
Robert A. Bullington, Northern Illinois State Teachers College, DeKalb, Ill.
Lula Casemore, MacKenzie High School, Detroit, Mich.

Chemistry

Louis Panush, Northeastern High School, Detroit, Mich.
Brother Fred. T. Weisbruch, Don Bosco High School, Milwaukee, Wis.
Robert L. Walker, Lyons Township High School and Junior College, LaGrange, Ill.

Elementary Mathematics

F. Lynwood Wren, George Peabody College, Nashville, Tenn.
Mrs. Clarence Ethel Hardgrove, Northern Illinois State Teachers College, DeKalb, Ill.
Elinor B. Flagg, Illinois State Normal University, Normal, Ill.

Elementary Science

Sister Mary Evarista, Mercy High School, Chicago, Ill.
Mrs. Emilie U. Lepthein, Division of Visual Education, Chicago, Ill.
Frank O. Youkstetter, Wayne University, Detroit, Mich.

General Science

John D. Woolever, Mumsford High School, Detroit, Mich.
Phil R. Gilman, East High School, Cleveland, Ohio
Fred L. Keil, Proviso Township High School, Maywood, Ill.

Mathematics

Dwain E. Small, Knox College, Galesburg, Ill.
Luther Shetler, Bluffton College, Bluffton, Ohio
Hobart Sistler, J. Sterling Morton High School, Cicero, Ill.

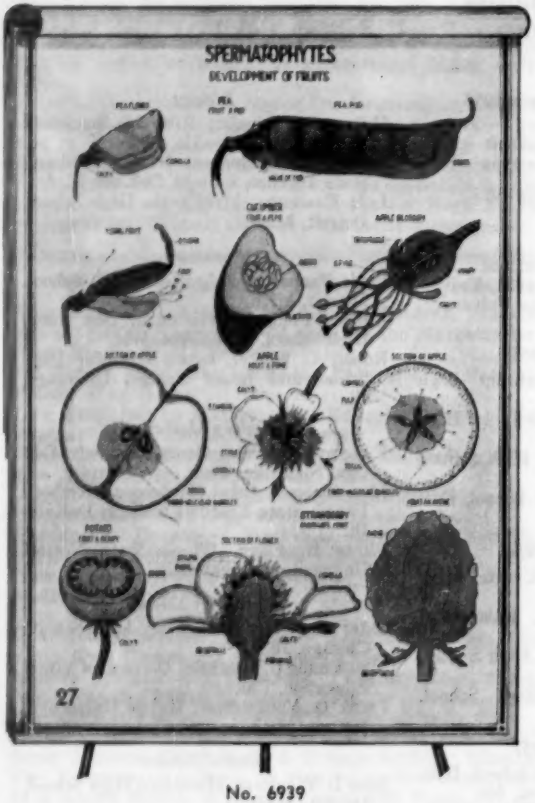
Physics

Bastian Fagginger-Auer, Hinsdale High School, Hinsdale, Ill.
Edwin Vaughn, Western Michigan College, PawPaw, Mich.
Robert L. Price, Joliet Junior College, Joliet, Ill.

Welch—Smallwood Biology Charts

in Diagrammatic Colors

For Teaching A Complete Course in Biology



No. 6939

These Widely Used Charts Are a Valuable Addition to the Elementary Biology Laboratory

UP-TO-DATE
EASY TO UNDERSTAND

DETAILED
But not Complicated

30 BOTANICAL CHARTS
with more than 400 drawings

30 ZOOLOGICAL CHARTS
with more than 350 drawings

SIZE 24 x 36 inches
with
NON-GLARE, WASHABLE, PROTECTIVE COATING

Available for Constant pupil reference—

No. 6939—BOTANICAL CHARTS, Set of 30, Tripod or Wall Bracket Mounting, Set, $27.50; Mounted on Round Steel Base with rollers—Set $37.50

No. 6940—ZOOLOGICAL CHARTS, Set of 30, Tripod or Wall Bracket Mounting, Set $27.50; Mounted on Round Steel Base with rollers—Set $37.50

No. 6941—BIOLOGICAL CHARTS, Set of 60, 30 Botanical and 30 Zoological Charts, Set $45.00 Mounted on Round Steel Base with rollers $55.00.

Write for Circular

W. M. Welch Scientific Company

DIVISION OF W. M. WELCH MANUFACTURING COMPANY
Established 1880

1515 Sedgwick St., Dept. S — Chicago 10, Ill. U.S.A.

SCHOOL SCIENCE
AND
MATHEMATICS

VOL. LV OCTOBER, 1955 WHOLE NO. 486

GRAINLESS FARMS

B. CLIFFORD HENDRICKS
457 24th Avenue, Longview, Washington

It may have been a farmer from the plains who came to the northwest and said,

"I arrived flat broke in midwinter,
I found it enveloped in fog,
And covered all over with timber,
As thick as hair on a dog.

I took up a claim in the forest,
And set myself down to hard toil,
For two years I chopped and I labored,
But I never got down to the soil."

That lament, not-with-standing, his sons did "get down to the soil." Their crops, however, confront the plainsman with some "unexpecteds."

MINT FARMS

Longview, Washington's Pacific Way skirts Columbia's flat flood plain. From its higher level we looked down upon a sizable herd of sheep. Our driver remarked that those sheep were "mint-field-weeders." "Their owner dares not use them more than one year," he said, "For after the first year the sheep get smart and eat mint as well as weeds."

One of the heavy cost items of mint farming is that of keeping the field free from weeds. Weeds, mixed with the mint, at the distillery, add "weed oil" to that of the peppermint. "Weed oil" has a flavor all its own and that flavor does not enhance the sale value of the peppermint oil. (Mint is raised, it should be remembered, for its oil.)

Mint farmers at their recent 1955 meeting heard favorable reports

upon the use of geese instead of sheep as weeders. One operator who used a flock of one thousand birds found he cut his weeding costs eighty per cent below that of Mexican labor.

Mint farms of the northwest produce about one third of all peppermint grown in the United States. They have increased their mint acreage over three fold in the last ten years. The other comparable mint farms of America are in Indiana and Michigan.

Bulb Farms

Seventeen year old Mary Carille was Daffodil Queen for Puyallup Valley Daffodil Festival the spring of 1954. The festival week-ended in a marine parade of 200 daffodil-decorated yachts. More than two million daffodils were used by the floats which entered the two-hour long parade.

But Puyallup Valley is but one of the bulb-farming areas of the northwest. At Woodland, Washington, the honored personage was Tulip Queen, Shirley Jones. Other bulbs cultivated on these bulb-farms are: lilies, hyacinths, iris, crocus and narcissus. The volume of production has become such that Dutch imports, in recent years, have felt the competition.

Bulb growing in the northwest began about fifty years ago. It reached its peak in 1948. Most of these bulb farmers got their experience in Holland. They generally work small acreages of about thirty acres. The gross returns on such a field is around $35,000 but the production costs may be as much as fifteen or twenty thousand dollars. So bulb-farming isn't likely to soon bring a "gold rush" to its fields. However, for its neighbors, its fields certainly add a colorful glamour to the landscape during bloom time.

Oyster Farming

The phrase "oyster farming" is not as far fetched as might at first appear. The commercial oysters of the northwest are planted. (Incidentally, in 1940 Washington state stood second in America's canned oyster pack.) The "seed oysters" are oyster larvae secured from Japanese waters. The larvae, when planted in Washington state coast waters, grow two or three times as fast as they do in their original home waters.

But oyster farming is not as simple as it may seem. There's more to it than: plant the seed and wait for them to grow to market size. The fact that it is unnecessary to provide any food for the crop may be why oyster farming is mistakenly rated a loafer's job. There is a sort of series of tasks that confront the oyster-cropper year in and year out; plotting the tide-land for seeding; planting the seed; spreading the growing oysters over the bed so they are able to feed and

fatten effectively; and finally the picking by hand or tongs. The last "round up" for the oyster is staged at the cannery. That, however, may be considered beyond the oyster-farmer's responsibility.

Cranberry Bogs

Cranberries are cultivated on the Cranguyma peat bog farms near Long Beach, Washington. While this is the largest single farm there are others in that area. The harvest in that peninsula region for 1954 was over one million pounds. The Cranguyma Farm not only grows cranberries but carries on a continuous study of uses. Just as George Washington Carver uncovered varied food and other uses for the sweet potato and the peanut so William Felz of Cranguyma Farm laboratories is lifting the cranberry to a respected and varied place upon the menus of the elite. It is reported that he now has fifteen different cranberry products available. The end is not yet.

That farm processes about twenty-five per cent of its production for sale in the form of these food specialties. The rest of the crop goes to the National Cranberry Association freezer plant for wider distribution. Scarcely any of the picking goes to "fresh market" marketing.

The northwest does not have a large fraction of the nation's total acreage or annual yield of cranberries. The industry, however, is under concerned study by the states of Oregon and Washington and its acreage is increasing. In the past thirty years Washington production has increased by over twenty times.

Tourists of the northwest are impressed by the "tall timber," the rugged terrain, and the tumbling fish-filled streams. There are, however, other arresting aspects of this region, not so obvious, but equally alerting for visitors who are not in too much of a hurry.

MCA NAMES DR. WILLIAM E. CHACE, DIRECTOR OF EDUCATION

Dr. William E. Chace has been named director of education by the Manufacturing Chemists' Association. Prior to his new appointment Dr. Chace had served as director of publications. He joined MCA in January, 1954. Immediately prior to this, he was Washington representative for Group Attitudes Corporation New York public relations firm.

A former college official and teacher, Dr. Chace holds an undergraduate degree from Princeton University, an M.S. from the University of Virginia and a Ph.D. from the University of North Carolina. During World War II he served as a White House Correspondent and for three years was with the Office of War Information, British Supply Council, for which service he was decorated by the British Government. The MCA represents over 90% of the productive capacity of the chemical industry.

THE 55th ANNUAL CONVENTION

The fifty-fifth convention of the "Central Association of Science and Mathematics Teachers" will begin at 9:15 A.M. on Friday, November, 25th in the Sheraton Cadillac Hotel, Detroit, Michigan. Have you received your "Yearbook" containing the details of the convention? Have you made your reservations at the hotel?

Teachers in and around Detroit have planned an excellent professional and social program for all. You owe yourself this professional opportunity. You should hear Dr. Howard Fehr, Dr. Harry Carver, and Dr. Rose Lammel. You will have the opportunity to visit the campus of Wayne University. You will visit the automobile capital of the world.

During this meeting, you will be called upon to vote on changes in the By-Laws. This will change the government of the association. New officers will be elected by the votes of those present.

You are reminded that this is your association. Its success in making contributions to education depends upon you. I would like to meet each of you in Detroit.

Send your reservations to:

Reservations Manager
Sheraton Cadillac Hotel
Detroit 31, Michigan

MILTON O. PELLA, *President*

RELIEF MAP OF CALIFORNIA

A big, colorful, relief map of California was published today by Aero Service Corporation, Philadelphia, worldwide aerial mapping company. The new map, printed in eight vivid colors on heavy plastic and formed in third dimension, puts map facts right at your fingertips.

The map is 41 by 47 inches. Its scale is 1 inch equals 16 miles (or a ratio of 1:1,000,000). The distance between Los Angeles and San Francisco on the map is 22 inches, or 352 air miles. A conventional plaster model of this size would weight over 200 pounds; this Vinylite map weighs only 2 pounds. The map surface has been plastic-coated so it can be marked freely with china marking pencil or wax crayons. Marks, dust and fingerprints wipe off easily.

Three maps are combined in one in this new relief map. It shows:

1) Land forms (mountains, valleys, drainage patterns)
2) Land use—10 different use categories
3) Geographic names—over 3,000 including 2,000 cities and towns, plus rivers lakes, canals and aqueducts, national parks and monuments, State parks, State and U. S. highways, railroads, military & Naval bases, civil airports.

The relief map of California costs $45.00, f.o.b. Philadelphia. It will be on sale in California stores or may be ordered from Aero Service Corp., Philadelphia 20.

If more information is wanted, please write or phone E. E. Dando, Aero Service Corp., 68 Post St., Room 420, San Francisco 4. His phone number is Yukon 2-4796.

"ENDLESS NUMBERS" (REPETENDS)

EXPRESS THE DECIMAL EQUIVALENTS OF COMMON FRACTIONS TO AN INFINITE NUMBER OF DECIMAL PLACES—WITH PERFECT ACCURACY

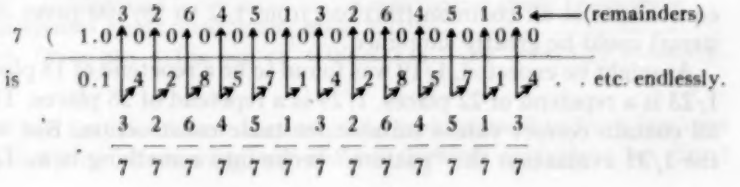
DONALD V. MITCHELL
12345 Sand Point Way, Seattle 55, Washington

In computing a table of decimal equivalents of common fractions (1/2 to 99/100), accurate to any desired number of decimal places, it is necessary to freely employ the properties of repetends (recurring decimals)—which have not been shown in elementary mathematics texts for over 100 years. What they are, and how they operate, becomes increasingly evident as the construction of the tabulation progresses.

With the exception of the prime numbers 1, 2, and 5, any prime number (and its multiples) when placed in the reciprocal (denominator) position and evaluated as a decimal, is a REPETEND—an endless number. For instance:

"1" divided by "3" is "the repetend three-tenths," or $.\dot{3}$, or .333333333333333333 · · · and on endlessly. In Repetend Notation a dot over a digit means that, for extreme accuracy, it may be repeated to any desired number of decimal places. 2/3 is $.\dot{6}$, or .666666666666666666 etc., an endless string of sixes. 1/9 is $.\dot{1}$ or an endless string of ones. 2/9 is $.\dot{2}$. or .222222222 etc. endlessly. 3/9 is $.\dot{3}$ (as above for 1/3). 7/9 is .777777 or $.\dot{7}$ if preferred. 9/9 (which exactly equals 1.000000) is exactly $.\dot{9}$—"the repetend nine-tenths." (That fact is very useful in precision computing.)

1/7 is the 6-place repetend $.\dot{1}42857$, or .142857142857142857 · · · and on endlessly. (Two dots above a number means that the digits indicated—and whatever is between them—may be repeated in the same order for as many times as is desired.) In the short-division setup hereunder, note that the "remainders" at each step are evaluated in the quotient as an endless decimal. They show correct values for all the 7ths—in convenient form—when placed in the order of their increasing values.



Tabulated in the order of their increasing values:

1/7	2/7	3/7	4/7	5/7	6/7	(7/7 to check)
$.\dot{1}42857\dot{1}$	$.\dot{2}85714\dot{2}$	$.\dot{4}28571\dot{4}$	$.\dot{5}71428\dot{5}$	$.\dot{7}14285\dot{7}$	$.\dot{8}57142\dot{8}$	($.\dot{9}99999\dot{9}$ or $.\dot{9}$)

(As used for percentage problems—and baseball percent standings:

14.29%	28.57%	42.86%	57.14%	71.43%	85.71%	and
.143	.286	.429	.571	.714	.857	)

To check for errors: Add the decimal value of 1/7 to that of 6/7 (to yield 999999), the values of 2/7 and 5/7, 3/7 and 4/7, and 1/7 and 2/7 to 4/7. This further verifies the fact that 7/7 (or 1.000000) exactly equals $.\dot{9}$—"the repetend nine-tenths."

The 7ths values show (in miniature) another very useful characteristic of repetends. Where applicable, it cuts the required computing operation in half. It is this: the digits in the first half of the array are the "negatives" of those in the second half—and the second-half digits are "negatives" of the first-half digits. (For our purpose, "the Negative" of a number is the difference between it and a like number of 9's.) Examples: The first half of the 1/7 value is 142. Then the second half is 857. (Check: when superimposed and added they yield "999".) Similarly, if given the fact that the value of the first half of 1/17 is .05882352, its second half is then 94117647. (Add them to verify as above.) The complete array is $.0\dot{5}88235294117647\dot{6}$—from which the tabulation of 17ths is easily set up. (Select starting points along the line which yield increasing values. 2/17 is .117647, 3/17 is .176471, 4/17 is .235294, etc.) Similarly 1/97 is a repetend of 96 decimal places. When the first 48 places are known then the rest may be written immediately as their "negatives." The array then shows all the values of the 97ths—from 1/97 to 96/97—with perfect accuracy to any desired number of decimal places.

When it was discovered that the decimal equivalent of 1/7 was a 6-place repetend which contained correct values for the other 7ths (2/7 to 6/7)—without further computing being required—and that the 1/17 value was a 16 place repetend which contained correct values for all the other 17ths (2/17 to 16/17), it began to appear that the expected "paper work" involving in computing the decimal equivalents of all common fractions from 1/2 to 99/100 (over 5000 items) could be greatly simplified.

As might be expected, 1/19 was found to be a repetend of 18 places. 1/23 is a repetend of 22 places. 1/29 is a repetend of 28 places. They all contain correct values suitable for table construction. But with the 1/31 evaluation the "pattern" broke into something new. They

require two 15-place repetends with which to show the decimal values of 1/31 to 30/31. For the 37ths twelve 3-place repetends are required. For the 41sts eight 5-place repetends are used.

Since such a table is something new to mathematics literature a brief explanation of its inception and significance is in order. In times past only a few tables of Decimal Equivalents were available. That of 64ths (of an inch) was commonly posted in machine shops of technical schools—1/64 to 63/64 evaluated as the decimals .015625 to .984375. (Incidentally, add the two values to get the decimal value of 64/64.) During the recent war-stress period—in the construction industries and allied agencies—there was a "crying" need for a "fast operating" table of the decimal equivalents of all common fractions from 1/2 to 99/100 (over 5000 items) correct to at least 6 decimal places.

In 1945 a highly condensed (4 page) version of the 10 page—5000 item—original tabulation was published. I had computed it for use in the Boeing Technical Training Program. It shows the original setup for the decimal equivalents of 1/2 to 52/53 and easily yields correct 6-place values for all the rest of the 5000 items (1/54 to 99/100) by adding two of the 7-place values from the tabulation of 1-to-9 times 1/54 to 1/100 shown there.

Hereunder is the start of both tables. (All decimal points omitted.)

Six Place DECIMAL EQUIVALENTS of Common Fractions (Repetends indicated)

Numerators → / Denominators ↓	1	2	3	4	5	6	7	8	9	10
3	333333	666666		In the Repetend notation, a dot over a digit means that it may be repeated to as many places as is desired. Two dots means that the digits indicated, and anything between them, are repeated in the same order.						
4	25	5	75	(4)						
5	2	4	6	8	(5)					
6	166666	333333	5	666666	833333	(6)				
7	142857	285714	428571	571428	714285	857142				
8	125	25	375	5	625	75	875			
9	111111	222222	333333	444444	555555	666666	777777	888888		
10	1	2	3	4	5	6	7	8	9	
11	090909	181818	272727	363636	454545	545454	636363	727272	818181	909090
12	083333	166666	25	333333	416666	5	583333	666666	75	833333
+10	916666	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
13	076923	153846	230769	307692	384615	461538	538461	615384	692307	769230
+10	846153	923076								
14	071429	142857	214286	285714	357143	428571	5	571428	642857	714286
+10	785714	857142	928571							
15	066666	133333	2	266666	333333	4	466666	533333	6	666666
+10	733333	8	866666	933333						
16	0625	125	1875	25	3125	375	4375	5	5625	625
+10	9375	75	8125	875	9375					
17	058824	117647	176471	235294	294118	352941	411765	470588	529412	588236
+10	647059	705882	764706	823529	882353	941176				

From "Take the Sting out of Mathematics." by Donald V. Mitchell.

When first published, the foregoing table seemed to have few uses beyond that of showing any desired decimal equivalent by direct

readings from the table. Later it began to be seen as a great time and energy saving tool for the quick solution of long-division problems. As commonly taught, the long-division operation is rated as the most awkward of all elementary-computing operations.

If one wishes to break that "bottle-neck"—solve division-type problems by SIMPLE ADDITION—try using the above table for the quick and easy solution of problems with two-digit divisors. Example: Divide 413.68 by 17. (Round each value even with the first one used.) The table shows that:

4 0 0	17ths is	2 3 5 2 9 4	(Use 4/17 with a point shift.)
1 3.	17ths is	.7 6 4 7	(Use 13/17 as is.)
6	17ths is	0 3 5 3	(Use 6/17 with a point shift.)
0 8	17ths is	0 0 4 7	(Use 8/17 with a point shift.)
4 1 3.6 8	17ths is	2 4.3 3 4 1	(Exact to 6 places.)

This shows that the table is a fast operating DIVISION TABLE—the first of its kind ever published. The 4-page—condensed version—is available for classroom use. The 10-page—5000 item—setup is as yet unpublished.

The Realm of Repetends is full of an astonishing array of unpredictable mathematical coincidences. It opens a new field in elementary arithmetic for original research and enjoyment.

For example: Notice what happens when a number is "doubled" over and over again—to any desired number of times. Example: Start with "7 doubled" (14). Double it again and again (28, 56, etc.) for as many times as you wish. For *each new value* allow the setup to extend just *two places* farther to the right. Use some convenient way to care for the overlap of carries. Add as shown.

| | | |

7) 1/11 is .0 9 0 9 0 9 0 $\dot{0}$ $\dot{9}$ — as shown in the Table.

3) 1/77 is .$\dot{0}$ 1 2 9 8 7 $\not{0}$ $\not{7}$ — as shown in the Table.

1/231 is .$\dot{0}$ 0 4 3 2 $\dot{9}$ (Beyond the range of the Table.)

1-to-9 times 1/231	1-to-9 times 231
1 — .$\dot{0}$ 0 4 3 2 $\dot{9}$	1 — 231
2 — .$\dot{0}$ 0 8 6 5 $\dot{8}$	2 — 462
3 — .$\dot{0}$ 1 2 9 8 $\dot{7}$	3 — 693
4 — .$\dot{0}$ 1 7 3 1 $\dot{6}$	4 — 924
5 — .$\dot{0}$ 2 1 6 4 $\dot{5}$	5 — 1155
6 — .$\dot{0}$ 2 5 9 7 $\dot{4}$	6 — 1386
7 — .$\dot{0}$ 3 0 3 0 $\dot{3}$	7 — 1617
8 — .$\dot{0}$ 3 4 6 3 $\dot{2}$	8 — 1848
9 — .$\dot{0}$ 3 8 9 6 $\dot{1}$	9 — 2079

				(To check.)			
1x0 0 0.	× 1/231	is	x0 0 4 3 2 9	6.	× 231	is	1386.
4x0 0		is	x0 1 7 3 2	3x		is	69 3x
7x0		is	x0.3 0 3	.08x		is	18.5
5.		is	.0 2 2	.006x		is	1.4
1 4 7 5.	× 1/231	is	6.3 8 6	6.386	× 231	is	1476.✗

Answer: The receptacle holds 6.386 gallons exactly.

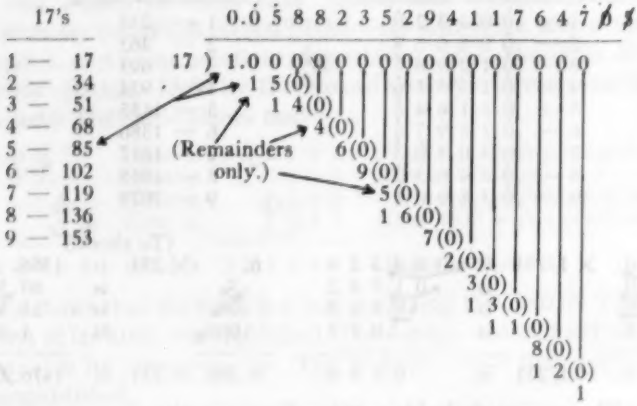
It should be noticed, in the foregoing solution, that both Multiplication and Division operations are accomplished by a very simple Addition. This is in line with the modern (scientific) trend to use methods and equipment which will make mathematical computing at all levels, easier and more accurate.

The sudden appearance of the 6-place repetend (1/231 evaluated) shows how easy and efficient computing is in the Realm of Repetends. If you complete the tabulation of the Decimal Equivalents of all the 231sts (1/231 to 230/231) you will find that it shows 198 6-place repetends, 30 2-place repetends (.$\dot{0}\dot{3}$, $\dot{0}\dot{6}$, etc.), and 2 1-place repetends (.$\dot{3}$ and .$\dot{6}$). The 198 items are shown on 33 6-place repetends—by moving the decimal point to other positions.

Furthermore, notice that in any of the 6-place repetends the sum of the digits used (added "horizontally") is always 9 or a simple multiple of 9 (18, 27, etc.). And that, if the complete table of 231sts is available (230 items), solve by adding 100 times the 14/231 value to the 75/231 value—6.060606 and .324675—to yield 6.385281 as the precise answer (to six decimal places).

The setup of "1-to-9 times" any factor—and its reciprocal—is a very useful operational method. It assures speed and exceptional accuracy by showing exact values for all nine of the possible partial products prior to their use in the problem. If then, by additive-subtraction (one digit at a time)—or by inspection—the difference is written immediately below the dividend (in place of the usual method of subtracting the partial product), the "next place" may be brought

down immediately in preparation for the next step of the solution. These features used to shorten long-division are clearly shown in the following example: Divide "1" by "17" to show it as a repetend of 16 places. (Show only the differences with "0" annexed.)



Another way to derive this particular repetend is to find the 1st four digits (as above or otherwise) and then multiply that value (0588) by 4 four or more successive times. Results: 2352, 9408, 37632, 150528, etc. Set them to follow each other but to use only 4 new decimal places at each step. (Care for the overlap of carries.) Add as shown.

| | | |

From all the foregoing it must be evident that repetends—known also as Recurring Decimals—express the value of their common fraction equivalents with *perfect* accuracy to an infinite number decimal places. Each one is a marvelous thing by itself, and an astonishing example of the scientific character of the *Science of Mathematics* in the Division Area—just as the tabulated *Multiplication Table* does in the Multiplication Area.

Although repetends have not been shown in mathematics texts for over 100 years their revival opens up a marvelous area for original research and enjoyment. They suddenly appeared, during the war-stress period, when an effort was made to quickly upgrade adults by presenting mathematics in its true character—AS PURE SCIENCE—instead of as an academic tradition. The saving in Time, Energy, and Man-Power was enormous. Anything really scientific is far superior to its traditional counterpart.

Something over 100 years ago the Master Mathematician Karl Friedrich Gauss (1777–1855) stated that "Mathematics is the Queen of the Sciences—and Arithmetic is the Queen of Mathematics." Only recently has the understanding of the nature of factual (scientific) thinking become sufficiently clear to permit its application to areas where traditional thinking has dominated educational practices. In an effort to improve mathematics we applied the now known laws of correct, scientific thinking to the known areas of elementary arithmetic—to see if the subject could be more effectively presented. The result was astonishing.

At each step the scientific nature of mathematical thinking revealed the subject in an entirely new light—as pure science—wherein everything is in correct order—perfectly related to everything else in the Realm of Mathematics—and operating with EASE, SPEED, and ACCURACY—and automatically precluding everything awkward, difficult, or involved. It was quite evident that, to "go over" at all, it must be presented *as pure science.*

Those who are serious about becoming Master Mathematicians over the range of elementary arithmetic—addition to solid trigonometry—are invited to add computing with the properties of repetends to their professional equipment. They require about 5th-grade level of operational thinking.

The Properties of Repetends are shown on pages 39 to 50 of *Take the Sting Out of Mathematics*, 1953, by Author-Publisher Donald V. Mitchell, 12345 Sand Point Way, Seattle 55, Washington.

Hobbyist's magnifier, a microscope-like instrument designed for examining such things as stamps, coins, leaves and mineral specimens, provides an erect unreversed image of the object viewed. Field of vision is unusually wide and the only light needed is ordinary room illumination.

BERNARD CLIFFORD HENDRICKS, EDITOR FOR SCIENCE

Professor Hendricks is so well known that even a few words of introduction seem entirely unnecessary. The editor of this JOURNAL had not been long on the job until he heard from Professor Hendricks of the Chemistry Department of Nebraska University. His article, "The Chemistry of Power" was published in 1927. Since then he has been a frequent contributor. In recent years, since he retired from active teaching, he has written on many science topics. He did not retire; he only changed places and continues his interest in science and teaching.

It would be superfluous to attempt to tell much of his preparation for teaching and research. Born in Jasper, Missouri Jan. 26, 1883; graduated from Jasper High School in 1898, from Peru (Neb.) Normal in 1906, Peru Teachers College in 1910, B.Ed., University of Nebraska in 1911, B.Sc., University of Chicago in 1914, M.S., University of Nebraska in 1923, Ph.D.

In 1913 he married Mary Elizabeth Curry. To this union were born two daughters both of whom married Doctors. His teaching experience includes that of a rural teacher, village school, principal, and superintendent. As a college teacher he was at Peru Normal, Peru Teachers College, University of Nebraska. At the last named he spent 33 years in the Chemistry Department closing in 1951 as Professor of Chemistry. He served as a radio instructor in the First World War. He is a member of the American Chemical Society, a Fellow of the AAAS, and has held leading offices in a number of the Nebraska State Chapters of these and other Associations. He is also a member of Sigma Xi and Phi Lambda Upsilon.

His research includes work in diffusion of gases through hot metals and alloys, thermo-density of sugar solution, and many studies in the educational field of chemistry. He is an author of both textbooks and laboratory manuals in chemistry, and has written many articles for the *Journal of Chemical Education*, SCHOOL SCIENCE AND MATHEMATICS and other educational journals. He is listed in *Leaders in American Science*, *Chemical Who's Who*, *Who's Who in American Education*, *American Men of Science* and other state and regional directories.

For his great interest in science in general we are listing him as our Physical Science Editor.

GLEN W. WARNER

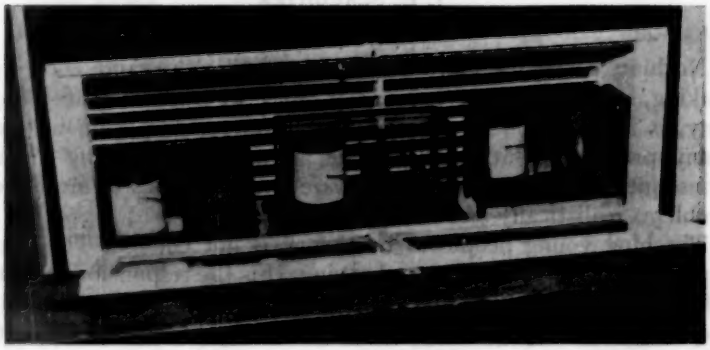
An error gracefully acknowledged is a victory won.
—CAROLINE L. GASCOIGNE.

A CLASSROOM WINDOW WEATHER STATION

GLENN F. POWERS AND WILL S. DE LOACH[1]
Arkansas State Teachers College, Conway, Arkansas

Atmospheric pressure can be measured inside a building, but temperature and humidity measurements need to be made on the outside air if they are to be related to the weather and its changes. A window box has been devised to hold a recording thermometer, a recording barometer and a recording hygrometer so that they measure and record external conditions, but are easily accessible and can readily be seen and read through the window.

A small, ventilated box with sloping shed-type roof was constructed and mounted just outside one of the physics lecture room windows. The box is approximately 39 inches long, 14 inches high at the front, and 10 inches high at the back, with a width of 12 inches.



The back of the box is louvered. The front of the box is of glass and hinged, facilitating access to the instruments. Lag bolts and metal braces were used to mount the box permanently on the building. The front of the box is just far enough from the classroom window to allow the window to be raised and lowered. The instruments can easily be seen and read through the glass without being disturbed.

The windows of the lecture room are far enough above ground level to preclude tampering with the box from outside the building without a ladder. The front is kept locked with a small padlock to discourage tampering from inside the building.

Once a week, the instruments are removed, clocks wound, and new records inserted. Each record is dated and the records are being saved.

Some difficulty was experienced with the barograph and the

[1] Present address: Catawba College, Salisbury, North Carolina.

thermograph which were old instruments. During extremely cold weather the clock motors occasionally stopped. It was found necessary to replace one motor and repair the other. A lighter oil than that ordinarily used seems advisable for such conditions.

Although the fact that the instruments are mounted so near the building undoubtedly affects their records, this disadvantage is more than offset by the gain in student interest. No attempt has been made to force students to observe these instruments, but they regularly congregate around the weather station between classes. In addition to the regular classes that meet in this room, it has been noted that other students in the building drop in to see "what the weather is."

MATHEMATICS AND MONEY

J. E. SLAUGHTER
Southern University, Baton Rouge, La.

Nothing consumes more of our time, thought, and energy as making, spending and saving money. Since we live in a money economy, it is a foregone conclusion that the average person will face many problems relative to making, spending and saving money. Consequently, teachers should prepare young persons to meet these problems realistically and intelligently.

Teaching young people to be thrifty is not enough. They need experience in both spending and saving. It is the responsibility of the school to provide opportunities for these experiences. Experience in spending and saving can best be gained through practice in the management of money and other economic resources.

Listed below are some suggestions for mathematics teachers who wish to provide experiences in the use of money for their pupils:

LEADING QUESTIONS

What is money?
Why do we need money?
What is meant by a family's income?
Does your family have a budget?
Is budgeting necessary?
Why is it necessary to save?
Which members of the family should make the spending and saving plans?
Do you have an allowance?
Why are goods bought on credit usually higher than goods bought for cash?

What is a savings account?
What is a checking account?
What is interest?
Why is interest on loans higher than interest on deposits?
What is the value of insurance?
What is the consumer price index?
Why does the government encourage persons to buy war bonds?

SUGGESTED ACTIVITIES

Operating a school bank
Working in the school canteen
Sponsoring and conducting the sale of savings bonds and savings stamps
Planning and issuing a school newspaper
Visiting banks, building and loan associations, post offices, insurance companies, tax collector's office, telegraph office, and pawn shops
Finding the cost of the supplies furnished by the school; finding the total cost and the cost per pupil
Writing deposit slips, checks, and receipts
Making budgets
Ordering from catalogues
Reading the gas meter and finding the cost of the gas used by the school
Examining contracts from several companies for the purchase of articles on time payments
Examining various kinds of insurance policies
Filling out income tax forms
Making a study of the average annual income of persons in various professions
Interviewing loan sharks, building contractors, representatives from the Better Business Bureau, and used car dealers
Having a panel discussion on the different ways of investing money
Making graphs to illustrate fluctuations in the cost of living
Working problems involving budgeting, banking, simple and compound interest, taxes, insurance, and stocks and bonds

---

Toy cookware, copper-clad stainless steel with cool, safe plastic handles, permit little girls to do a little honest-to-gosh cooking, not just "play-cooking." Small replicas of a popular line of utensils, the cookware looks just like Mom's.

Insect killer, a cone that burns slowly like a cigarette, disperses a deadly vapor in the air. Used as directed, in a closed room, the new product kills flies, mosquitoes, sandflies, moths, wasps, spiders, silverfish, ants and roaches.

THE DECIMAL POINT IN SLIDE RULE CALCULATIONS

DON L. LEWIS
New Dorm, San Marcos, Texas

The primary purpose of a slide rule—to quickly and with some accuracy make length calculations—is often defeated by the user's inability to speedily locate the decimal point in his answer. The following method for placing the decimal point is quickly learned and will give the user of it a new confidence in the accuracy of his slide rule calculations.

It is found convenient when working with large numbers to express the number as less than ten and multiplied by the appropriate power of ten. Thus 768,000 becomes 7.68×10^{5} and similarly 0.00768 becomes 7.68×10^{-3}. This procedure is easily recognized as simply finding the characteristic of the number as in logarithms.

When multiplying with the C and D scales, the movable scale either projects to the left or right of the body of the slide rule. When working with the C and D scales, a projection to the left adds 1 to the characteristic of the answer when multiplying or subtracts 1 from the characteristic of a quotient. The characteristic of a product will equal the sum of the characteristics of the multipliers plus the characteristic of one added each time a projection occurs. (When multiplying like numbers the exponents are added.) Similarly a division problem which results in a leftward projection of the movable scale will subtract one from the characteristic of the quotient. In combined operations of multiplication and division, the net change in characteristic because of leftward projection added to the sum of the multipliers from which have been subtracted the sum of the divisors will give the characteristic of the answer.

$$\frac{(760.0)(89.0)}{35.0}=193.0$$

1 projection in multiplication
−0 projection in division
+2 characteristic of 1st factor
+1 characteristic of 2nd factor
−1 characteristic of divisor

+2 characteristic of answer

The process for determining the decimal point when using the reciprocal scale (CI scale) is identical except a change in characteristic of the answer occurs upon rightward projection of the movable scale.

The beginning user of this method may at first write down the characteristics added or subtracted as a result of projection but later he will find that he will be able to mentally calculate the characteristic.

AN IMPROVED AND CONVENIENT APPARATUS FOR BURNING PHOSPHOROUS IN A VOLUME OF AIR

TO DEMONSTRATE THAT AIR IS APPROXIMATELY 1/5 OXYGEN

MENNOW M. GUNKLE

Thornton Township High School and Junior College, Harvey, Ill.

No data is at hand to show how many instructors in chemistry, at the secondary school level, allow the students to handle white phosphorous in the laboratory. It would be predicted that none do so. However, using white phosphorous in the classic experiment to show that a volume of atmospheric air approximates one-fifth oxygen by the method of floating phosphorous on a hollowed out cork, or in

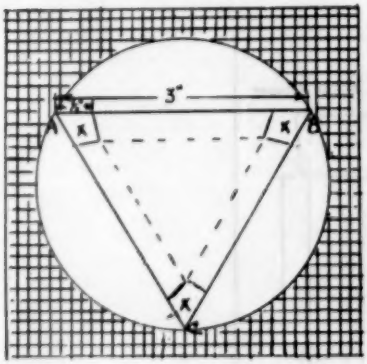


FIG. 1a. Showing construction of triangular tray for holding phosphorous; (1) cut out triangle *ABC;* (2) cut out corners marked *X;* (3) fold along dotted lines.

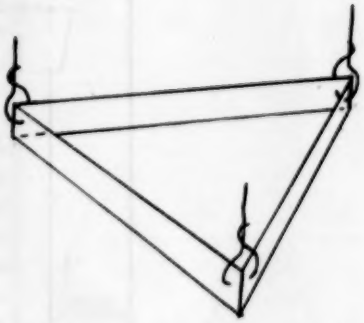


FIG. 1b. Showing corners of tray tied together with nichrome wire.

a crucible, and then trying to place an inverted hydrometer jar over it, is dangerous, cumbersome, and most inaccurate. With expansion of the heated volume of air it is always probable that the gas will bubble under the lip. Many times the cork or crucible tips which necessitates beginning the experiment over. Igniting the phosphorous with one hand and placing the jar with the other is awkward procedure. Safety precautions are practically cast aside each time this old method of procedure is followed.

In the following is found an improvement that provides safety, ease of manipulation, and fairly accurate results. The preparation of the apparatus will involve a little of the instructor's time at first but the instrument lasts a lifetime for demonstration purposes.

MATERIALS NEEDED: 1 hydrometer jar (one-liter capacity), 1 battery jar (one-gallon capacity), large one-hole rubber stopper to fit the hydrometer jar, short piece of glass tubing—4–5 inches long, small rubber stopper—number 1 size, piece of iron wire 1/16 inch in diameter (handle from deflagrating spoon), wire-asbestos mat, nichrome wire.

Assembling the Apparatus: The first problem is to get a hole, approximately 1/2 inch in diameter, in the side of the hydrometer jar just above the base. One may attempt it himself or send it to a glass company to be done. The short piece of glass tubing is placed through the large rubber stopper. The tray for holding the phosphorous is made from a wire-asbestos mat. Nichrome wire is used to hold the tray suspended from the large rubber stopper. A three-cornered tray is easily constructed and is shown in Figures 1a and 1b.

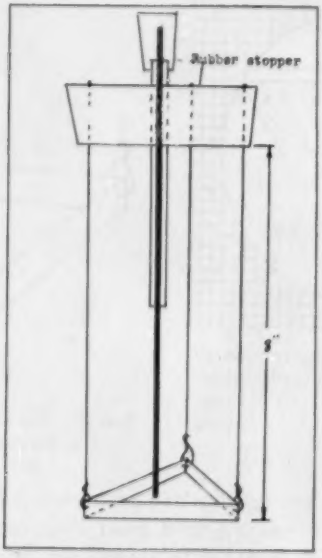


FIG. 2. Showing assembly of items onto large rubber stopper.

The tray should hang approximately 8 inches under the rubber stopper. Also the iron wire, or ignition wire, should extend from the small (number 1) rubber stopper through the glass tubing almost to the bottom of the tray. The small stopper should be bored out about 1/4 inch deep around the inserted wire so as to fit snuggly onto the top of the glass tubing which protrudes slightly above the large rubber stopper, making it air tight when closed.

Figure 2 is a diagram of the large stopper, glass tube, small stopper and iron wire, nichrome and tray assembly.

Before using the completely assembled apparatus the hydrometer jar may be marked so that readings can be observed rather than measured. Marks may begin 12 inches below the lip end and graduated in 1/4 inch divisions. The cylinder can be marked with red pencil and then shellacked to preserve the markings. The apparatus is now ready for use and Figure 3 shows the whole assembly.

Procedure in Operating: Remove the small stopper and the ignition wire from the glass tubing. Remove the large rubber stopper assembly and place in a convenient position close to the battery jar. With the hydrometer jar standing in the battery jar add water until the meniscus is at the lower mark on the hydrometer jar. The hole at the bottom of the hydrometer jar provides a means for the water levels to

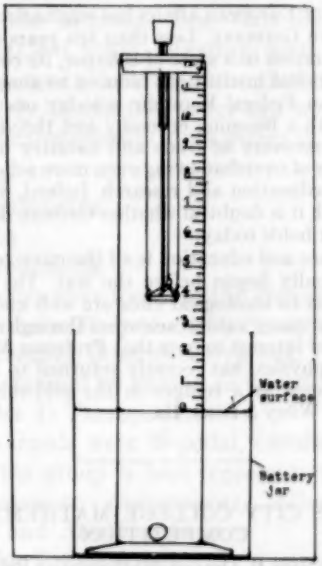


FIG. 3. Showing assembly of hydrometer jar standing in battery jar.

become equal. Have the white phosphorous handy, under water. Hold the roll of phosphorous with a pair of tongs under water in a water pan and cut about 1/4 inch from the roll. Pick up the large rubber stopper assembly with one hand and with the tongs in the other place the cut piece of phosphorous in the asbestos tray. Quickly place the assembly in the hydrometer jar. At this time it is convenient to clear the table of the loose phosphorous and the water pan by

putting these materials out of the way. Now press the large rubber stopper firmly in the hydrometer jar so as to effect an air tight seal—moistening the stopper aids in this. Pick up the small stopper containing the iron wire. Heat the end slightly in a bunsen burner flame. Put the end down through the glass tubing, touch the phosphorous in the tray, then press the stopper down over the glass tubing effecting an air tight seal.

The apparatus is now in operation and can be observed. When the reaction is completed and the hydrometer jar is at room temperature the water level outside the H-jar should be brought back to the original height. Calculation will show that water now occupies close to 20 per cent of the original air volume inside the hydrometer jar.

THE RECOVERY OF WESTERN GERMANY

Every recent survey of European affairs has emphasized the astonishing post-war recovery of Western Germany. Less than ten years ago the country was in ruins, its civil administration in a state of collapse, its commerce at a standstill, its scientific and educational institutions reduced to almost complete inactivity. In contrast, the German Federal Republic is today one of the strongest states in Western Europe, with a booming economy and thriving international trade.

Western Germany's recovery of trade and industry has been so spectacular that it is in some danger of overshadowing even more solid achievements in some other fields, notably in education and research. Indeed, without the tremendous contributions of research it is doubtful whether German industry would be in the commanding position it holds today.

The recovery of science and education is all the more remarkable in that their disintegration had actually begun before the war. The consequences of Nazi efforts to turn education to ideological ends are well known. So are the results of the loss of many of Germany's ablest scientists through emigration or dismissal. In this connection it is of interest to note that Professor Max Born, one of 1954's Nobel prizewinners in physics, has recently returned to Heidelberg from Edinburgh where he had come as a refugee in the mid-thirties.—Wiley Bulletin, Overseas Edition, John Wiley & Sons, Inc.

LOS ANGELES CITY COLLEGE MATHEMATICS PRIZE COMPETITION

The Fifth Annual William B. Orange Mathematics Prize Competition for Los Angeles high school students was held May 14, 1955 with 171 students from 38 schools participating. Teams of up to five students were selected by the mathematics departments of the respective high schools to take the 2½ hour written examination.

Individual honors went to Don Charnley, Franklin High School, and Gordon Hughes, Hamilton High School, who tied for first place. Each wins $25 and an engineer's slide rule.

Team honors went to Van Nuys High School, winning a year's possession of the William B. Orange Competition 40 inch bronze trophy, with appropriate engravings. The Van Nuys team consisted of Louis Jaeckel, Mel Cheslow, and Mike Raugh, who placed 3rd, 4th, and 6th respectively. Close runner-up was Verdugo Hills High School, placing 4 in the top ten.

DINOSAURS YESTERDAY—PETROLEUM TODAY

JAMES K. ANTHONY
Southern University, Baton Rouge, Louisiana

Probably no animals that have ever roamed the earth—past or present—have intrigued man as much as those menaces of the Mesozoic, the dinosaurs.* Man's imagination has been allowed to run riot in attempting to visualize life in that bygone era. Fossil remains of many of these creatures give mute testimony of the strenuous struggle the smaller animals had for survival on the one hand and how the forces of nature subdued the larger animals on the other. What has contemporary man found out about these prehistoric creatures? Aside from being biological oddities what is this relationship of the past with the present?

Of the hundreds of prehistoric animals our discussion will concern the reptiles of the Mesozoic Era. This unit of geological time lasted about 200,000,000 years. Starting with the Triassic period 140,000,000 years ago and extending through the Jurassic to the Cretaceous approximately 60,000,000 years ago we find many bizarre-looking monsters. Taxonomically, this group is listed as follows:

Phylum Chordata
Sub-phylum Vertebrata
Class Reptilia
Order 1: Saurischia

These animals were found in the Triassic, Jurassic and Cretaceous periods. They had front teeth and side teeth. Some were carnivorous, others herbivorous. The animals were further characterized by having an anteriorly-located pubis.

Sub-order 1: Theropoda

These animals were bi-pedal, carnivorous and lived upland. This group is best represented by the *Allosaurus*, *Tyrannosaurus*, *Gorgosaurus*, *Albertosaurus*, *Dromaeosaurus*, and *Struthiomimus*.

Sub-order 2: Sauropoda

These were the swampland dwellers. They were quadripedal and herbivorous. They had front teeth in their small skulls which were located at the end of their long necks. Their tails were as long as their necks. Some of these relatively docile creatures were the *Plateosaurus*, *Diplodocus*, *Brontosaurus*, *Brachiosaurus*, *Barosaurus*, *Morosaurus*, and *Camarasaurus*.

Order 2: Ornithischia

* Greek: ΔΕΙΝΟΣ, terrible; ΣΑΥΡΑ, lizard.

The animals in this order were characterized by having a bird-like pubis, parallel with the ischium. They were herbivorous and existed during the Jurassic and Cretaceous Periods.

Sub-order 1: Ornithropoda

These duck-billed dinosaurs were bi-pedaled and quadripedaled and were inhabitants of swampland regions. Examples were the *Trachodon*, *Corythrosaurus*, *Troödon*, *Saurolophus*, and *Pachycephalosaurus*.

Sub-order 2: Stegosauria

The outstanding representative of this group was the *Stegosaurus*. It was an upland dweller living during the Jurassic Period. It had four feet and is commonly referred to as a plated-dinosaur. There were huge bony plates on its back and spikes on its tail, which it could wield with malicious intent that was more successful than erroneous.

Sub-order 3: Ankylosauria

These were the armored dinosaurs. They were quadripedal and were equipped with scutes and spines. They roamed the upland regions during the Cretaceous Period. The *Nodosaurus*, *Paleoscincus*, and *Ankylosaurus* were outstanding members of this group.

Sub-order 4: Ceratopsia

To this order belong the horned dinosaurs which were quadri-pedaled with large skulls having one or more vicious-looking horns. They, too, lived upland during the Cretaceous. Some of the more prominent representatives were the *Psittacosaurus*, *Protoceratops*, *Leptoceratops*, *Triceratops*, *Monoclonius*, *Pentaceratops*, *Anchiceratops*, and *Ceratops*.

It takes a healthy stretch of the imagination to visualize what life on earth was like during the Mesozoic Era. It was here that one can well apply the survival of the fittest law with meaning for a three-ring circus was always in progress with death to the loser and a full stomach to the winner. Paleozoic ferns grew everywhere and Mesozoic animals fed upon them. The Paleophis of the Cretaceous which resembled the present-day python, slithered noiselessly along the branches of cycadaceous trees in search of unwary prey. The herbivorous Stegosaurus munching lycopodiums and equisetums, if caught off guard, would fall a victim of a preying Allosaurus unless his spike-tail could deal a death blow in much the same way as an alligator today knocks out its prey. The Brontosaurus of the swamp-

lands became a favorite feast for any invading Tyrannosaurus Rex, probably the most vicious of all carnivorous animals. And the members of the ceratopsia were well avoided by less formidable animals because of the saber-like horns on their skulls.

The oceans and epeiric seas had their share of *dramatis personae*, too. From the crocodile-looking Phytosaurs of the Triassic swamplands up to the Mosasaurs and Plesiosaurs of the Cretaceous the great waters were scenes of many fatal struggles among these deep water denizens. Nor was there any peace in the air. From the primitive flying lizard, the Rhamphorhynchus of the Jurassic to the flying reptile, the Pteranodon of the Cretaceous, these and other nightmarish species patrolled the air and carried on the slaughter of life there.

Partial and complete fossils of many of these Mesozoic mutants can be found in several of our leading museums especially at Peabody Museum at Yale University; South Dakota School of Mines, Rapid City; University of California at Berkeley; Denver Museum of Natural History; American Museum of Natural History, New York; University of Michigan Museum, Ann Arbor; Texas Memorial Museum, Austin; University of Kansas Museum, Lawrence; Smithsonian Institution, Washington; Carnegie Museum, Pittsburgh; University of Utah Museum, Salt Lake City; Chicago Museum of Natural History; and Museum of Comparative Zoology, Harvard University, Boston.

Not only was there turmoil in every swampland and unrest in every upland but the earth itself was unstable. Having been formed only a few eons previously the earth was still subject to growing pains. Cooling land masses seemed not to stay put but had tendencies to float around, breaking off from parent masses here, floating off to isolation there.

Belching volcanoes, like Roman gluttons, spewed the land with destruction only to be followed with the invasion of epeiric seas which cooled as well as covered the land. The presence of marine fossils as far inland as Ohio give evidence that the United States has undergone such seasons of sea submergence. Fossils of the ichthyosaurs (aquatic reptiles) have feen found in Kansas, long-necked sea lizards (Plesiosaurs) up to 40 feet in length have been found in California; and mosasaurs (large aquatic reptiles) have been found in chalk deposits of many of our midwestern states.

As the land subsided many of the terrestial animals perished by being engulfed in the muck and water. And water seeping into the earth's hot interior created many diastrophic results. The continuous deposition of silt of the epeiric seas further buried the fallen reptiles. With the emergence of land, causing the seas to drain into the

oceans, aeolian soil weighted the sediments down compacting them into rock. Rising land masses and buckling of the earth's surface, after repeated gestures, produced essentially part of the present topography of the United States. Thus the combined effects of internal heat and external pressure altered the decaying animals into pronounced hydro-carbon compounds, the chief constituent of petroleum. Those masses not affected have remained as fossils.

An interesting angle of the above is the correlation between regions of petroleum exploitation and areas of fossil finds—they almost occur together. Fossils have been found in Ohio. But Ohio, Pennsylvania, Kentucky, Indiana, Illinois, and Michigan are oil producing states. Prehistoric remains of animals have been unearthed in Texas and Oklahoma and this region is rich in oil reserves. The mountain states as well as California have produced interesting Mesozoic skeletons. Petroleum from these regions has produced fabulous millionaires, too. In fact, about 80% of the United States petroleum output comes from Louisiana, Texas, Oklahoma, and California.

Recent oil exploitation on our Gulf and Pacific continental shelves has tended to mark the last stands of our aquatic animals of the past. Just how many of these animals existed naturally will never be known. If our petroleum is a product of their decomposed bodies then the earth must have been abundantly populated with them if our current exploitation of petroleum is any indication. Realizing that petroleum is a non-replaceable resource just how long it will be available to us is a matter of conjecture. Some economists and conservation authorities have warned that our reserves of petroleum will be exhausted within a decade. Oil engineers have been developing effective methods of re-pressuring non-producing wells to recover residual oil that could not be pumped up to the earth and they avow that man will enjoy petroleum and their products for many years to come. And, who knows, maybe with further research on Einstein's memorable $E=mc^2$ man will become less dependent upon so many uses of petroleum.

DEAN ELVEHJEM TAKES ON AN IMPORTANT CHAIRMANSHIP

Conrad A. Elvehjem, dean of the University of Wisconsin Graduate School, was recently appointed chairman of the Food and Nutrition Board of the National Research Council.

He has been a member of the board since it was organized in 1941 to study the basic problems of nutrition in United States. He served as vice-chairman last year.

One of the board's important accomplishments was the setting of recommended dietary allowances for humans. At present, one of its projects is evaluation of the safety of chemical additives in foods.

The board is composed of 20 of the nation's outstanding scientists, with 14 subcommittees and liaison representatives from all government agencies concerned with nutrition.

MATHEMATICAL THOUGHT FOR THE MORROW

LESTER H. LANGE
Valparaiso University, Valparaiso, Indiana

I. INTRODUCTION

For the student of mathematics the transition to, say, the study of calculus from the study of the group of subjects in high school and early collegiate mathematics may be somewhat abrupt and strange and consequently, in prospect, forbidding. The good teacher hence tries to pattern his exposition of these subjects with this in view. It is almost trite to say that each course must be taught with the next courses in view—to do otherwise is to do a disservice to the good student, at least. The ideal transition is one for which the student is unobtrusively prepared. This preparedness can perhaps best be effected by the choice and use of *pregnant problems* as expositional material. The dramatic effect can be heightened if the problem is of an innocuous appearance—and dramatic effects are undoubtedly very important to the mathematics teacher who thinks highly enough of his field to regard it as a *liberating discipline* and hence worthy of the attentive pursuit of his students. Needless to say, the teacher who is inventive enough and observant enough not to be a slave to the textbooks also increases his effectiveness.

II. A CASE IN POINT

A Problem of Innocuous Appearance. I consider this trigonometry problem: From the top of an observation tower of altitude 172 feet an observer sees two ships which are in the same vertical plane with the tower. The angles of depression of the two ships are 27°13′ and 35°28′, respectively. How far apart are the ships? (There are two possible cases. I take first the case in which both ships are on the same side of the tower.)

III. THE SOLUTION

Since it is usually far better to work a problem with *letters* rather than with *special* numerical values, letters are assigned rôles as shown in Figure 1. (Letters are chosen so that $\alpha < \beta$—this will make it easier for us to check our work, both at intermediate stages and in

FIG. 1

the final form. That is, the notation makes it easy to remember "which angle is which.")

With the aid of "alternate interior angles" it is easy to write $x=t \cot \beta$ and $x+d=t \cot \alpha$, after the quite natural introduction of the "auxiliary unknown," x. Not being interested in x, we eliminate it readily from these two equations and have the solution:

$$d=t\,(\cot \alpha-\cot \beta).$$

IV. Checking the Solution

(a) The coefficient of t in our solution is a pure number and hence both sides of the solution equation are, properly, linear in dimension.

(b) For fixed values of α and β, it is seen that an increase in t results in an increase in d. This is also as it should be.

(c) For $0° < \alpha < \beta < 90°$, $\cot \alpha > \cot \beta$ and hence $d > 0$.

(d) If α and β differ "greatly," d should be "large." Our formula does exhibit this quality.

V. More Checking

Let $\theta=\beta-\alpha$ and consider the situations depicted in Figure 2. If $\theta_1=\theta_2$, it will *not* follow that the corresponding distances, d_1 and d_2 will satisfy $d_1=d_2$. In fact, we *should* have $d_1>d_2$. Does the formula in section III satisfy this requirement? (Note that the first case requires α and β to be "small," whereas the latter case requires them to be "large.")

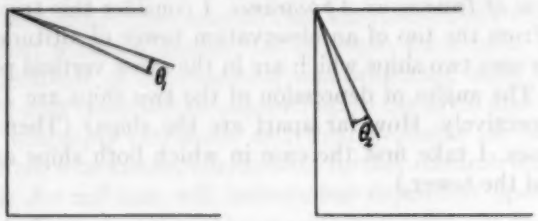


Fig. 2

Consider an example:

$\alpha=13°$	$\alpha=74°$
$\beta=15°$	$\beta=76°$
$\theta_1=2°$	$\theta_2=2°$
$\cot \alpha-\cot \beta=$	$\cot \alpha-\cot \beta=$
$4.3315-3.7321=$	$0.2867-0.2493=$
$0.5994.$	$0.0374.$

The fact that $0.5994 > 0.0374$ is as it should be. However, how can we answer our question *in general*? Better yet, how can we *ask* our question in general?

VI. A Tabular Digression

Let $\phi(\alpha, \beta) = \cot \alpha - \cot \beta$. Then $d = t\phi$. If, now, we had the regular job of computing this distance between ships—ah, what a job!—we would be well-advised to make ourselves a *table* of this function. (Every entry could be multiplied by some particular value of t, if we wished, though this would perhaps be unwise if we were very actively itinerant in our tower tending!) A partial table appears in Figure 3.

$\varphi(\alpha,\beta)$

$\alpha \backslash \beta$	1°	2°	3°	4°	5°	15°	86°	87°	88°	89°	89.5°
1°	0	28.65	38.21	42.99	45.86	53.52				57.27	
2°	-28.65	0	9.56	14.34							
3°			0	4.78	7.65			19.03			
13°						.599		4.279			
85°							.0176	.0351	.0526	.0700	
86°							0	.0175	.0350	.0525	
87°			-19.03					0	.0175	.0349	.0437
88°									0	.0174	.0262
89°										0	.0088

Fig. 3

VII. Back to the Question

Consider the behavior of $\phi(\alpha, \beta)$. If β "pulls away" from α, *i.e.*, if θ grows, then $\phi(\alpha, \beta)$ grows in value. The *size* of that growth in ϕ, however, is not only dependent on θ, but also on the sizes of α and β, apparently. For example, it could depend on whether α is nearer to 0° than to 90°.

We can proceed something like this. The recurring quantity $\beta - \alpha$ has been given a name, $\beta - \alpha = \theta$. Hence, $\beta = \alpha + \theta$, and then

$$\phi = \cot \alpha - \cot(\alpha + \theta).$$

Now, if θ grows, so does ϕ; *i.e.*, the *difference*

$$\phi(\alpha, \alpha + \theta) = \cot \alpha - \cot(\alpha + \theta)$$

grows when θ grows. It has already been observed that this quantity is a function of α in such a way that, if α is "small"—*i.e.*, near zero —then this difference will be larger, for a fixed value of θ, than it would be for α near 90°.

Conversely, the expression $\phi(\alpha, \alpha+\theta)$ decreases if θ decreases. Here also, the *comparative* size of the decrease in ϕ depends upon α. For example, if α is near 0°, a *small* decrease in θ can produce a *comparatively large* decrease in ϕ. (Remember the figures, I and II.)

These various observations might lead us naturally to *compare* the quantity $\phi(\alpha, \alpha+\theta)$ with the quantity θ. We consider the expression

$$E(\alpha,\theta)=\frac{\cot\alpha-\cot(\alpha+\theta)}{\theta}.$$

Note well that $\theta>0$ throughout the discussion. We must stipulate $\theta\neq 0$ with good reason. In fact, the value of the expression, E_1 for $\theta=0$, even if it *were* defined, holds no interest for us. (If the two ships were in exactly the same position, it would not be the distance which separates *these* two ships that would concern us. Of transcendant interest would be the distance to the nearest hospital ship!)

We are *now* in a position to *ask our question in general form:* is it true that

$$E(\alpha', \theta) > E(\alpha,\theta)$$

if

$$0°<\alpha'<\alpha<90°?$$

We are interested in the value of $E(\alpha, \theta)$ for *small* values of θ. Now, it is the *differential calculus*, which tells us, after but a few days of introduction to that subject, that, when θ is very "small," but $\theta\neq 0$, the

$$E(\alpha, \theta) \doteq K(\csc\alpha)^2,$$

where $K=\pi/180°$. (The notation "$\doteq$" can be read as "is approximated by.") In fact, it is there proved that

$$\lim_{\theta\to 0} E(\alpha,\theta) = K(\csc\alpha)^2,$$

which merely says that *the approximation can be made as good as you want it to be.* Another way of putting it is to say that if it is desired that the value of $E(\alpha, \theta)$ should differ from $K(\csc\alpha)^2$ by less than a certain pre-assigned amount, it is *always* possible to choose θ small enough, *i.e.*, close enough to but not equal to zero, so that this will be so.

Has our question, at long last, been answered? The answer is yes!

For the function $(\csc \alpha)^2$ possesses the qualities we seek. For, if α is small, $(\csc \alpha)^2$ is large; if α is large—nearer to 90°—then $(\csc \alpha)^2$ is near unity; and $E(\alpha, \theta) \doteq K(\csc \alpha)^2$.

VIII. A Computational-Checking Digression

Our table gives $\phi(88°, 89°) \doteq 0.0174$. What is the corresponding value of our approximation to $E(88°, 1°)$? Well,

$$E(88°, 1°) \doteq \frac{\pi}{180°} \cdot \frac{(\csc 88°)^2}{1°} \doteq 0.0175.$$

Note: Our final result can be stated as:

$$\phi(\alpha, \beta) \doteq (\beta - \alpha) \cdot \frac{\pi}{180°} \cdot (\csc \alpha)^2,$$

$\beta - \alpha$ being "small."

IX. We Push On

Gentle Reader, let us not yet be disposed to leave these precincts! I do not mean that I shall take time to consider the case which finds the two ships on exactly *opposite* sides of the tower. I do mean to look, only briefly, at the case in which the two ships and the tower are *not in the same vertical plane*. This situation is depicted in Figure 4.

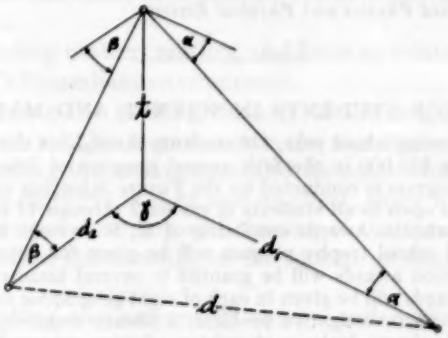


Fig. 4

Our problem now reads:

GIVEN: t, α, β, γ.

FIND: d.

The case for $\gamma = 0°$ has been exhaustively investigated; the case for $\gamma = 180°$ merely changes a minus sign to a plus sign in that solution.

The consideration of a solution for $0° < \gamma < 180°$ brings us face to face with the well-known Cosine Law—which can be remembered or derived on the spot—and this enables us to write:

$$d^2 = f^2[\cot^2 \alpha + \cot^2 \beta - 2 \cot \alpha \cot \beta \cos \gamma].$$

It is getting late and we are far from home. We'd better head back! We followed an innocent-looking path and we have seen quite a few points of interest along the way.

A CARNEGIE TECH PROFESSOR INVITED TO PARIS

The University of Paris has asked Carnegie Tech Professor Roman Smoluchowski to become Visiting Professor of Physics for their next academic year.

Announcing his acceptance, Dr. Smoluchowski said he will give a course on solid state physics at the Sorbonne and do research at the Ecole Normale Superieure.

Professor of Physics and Metallurgical Engineering at Pittsburgh's Carnegie Institute of Technology, Dr. Smoluchowski received his education in European institutions. He received a Master of Arts from the University of Warsaw, Poland in 1933 and a Ph.D. from the University of Groninger, Holland in 1935.

He is a Fellow of the American Physical Society and a member of numerous professional and honorary societies. Before joining the Carnegie Tech faculty in 1946, Dr. Smoluchowski was a research physicist for five years with the General Electric Company and before that taught physics and mathematics at Princeton University. In addition to his professorship he is a staff member of the Metals Research Laboratory at Carnegie.

The author of over 100 scientific articles, he is also associate editor for the *Journal of Applied Physics* and *Physical Review.*

AWARDS FOR STUDENTS IN SCIENCE AND MATHEMATICS

During the coming school year, 140 students throughout the nation will share awards totalling $10,000 in the fifth annual program of Science Achievement Awards. The program is conducted by the Future Scientists of America.

The contest is open to all students in grades 7 through 12 in public, private, and parochial schools. Awards consisting of U. S. Savings Bonds, gold pins, certificates, and school trophy plaques will be given for outstanding projects. Honorable mention awards will be granted to several hundred additional students. Equal awards will be given in each of eight geographic regions.

Any project—an investigative problem, a library research, model building, etc.—in general science, biology, chemistry, physics, or any field of science or mathematics at any grade level (7 through 12) is eligible for entry. Special national awards will be given for projects that deal with metals or metallurgy. Project reports must be mailed to Regional Chairman not later than March 15.

Plastic guard for circular table saws protects operators of saws with blades of six- to 16-inch diameters. In place, the transparent guard permits a clear view of the work, while completely covering the blade, with only enough room under the guard to allow the wood being cut to enter.

EXPERIMENTAL STUDY ON THE TEACHING OF SCIENTIFIC THINKING IN A PHYSICAL SCIENCE COURSE AT THE COLLEGE LEVEL

ROGERS E. RANDALL
Southern University, Baton Rouge, Louisiana

PROBLEM

The purposes of this study were: (1) to determine to what extent students enrolled in the first semester course of a physical science course, taught by the writer, developed their critical evaluation of scientific articles as one means toward the development of the ability to think scientifically; and (2) to what extent the students comprehended and profited by the factual information contained in the course.

PHYSICAL SCIENCE COURSE

The physical science course was organized for non-science majors. The course was planned to help the student to progress towards:

1. Acquiring ability to think critically in problem-solving skills by understanding and using the scientific method.
2. Developing an understanding and an appreciation for certain fundamental concepts in mathematics as related to science and everyday living. These fundamental concepts involved numbers and number systems and units of measurement in both the metric and English systems.
3. Understanding matter, motion, and force as related to our universe and man's immediate environment.
4. Understanding the existing theories of the origin of the solar system and man's relative importance in the universe.
5. Understanding the atmosphere and its most common changes which affect the daily life of man and its effect, along with other factors, on the constant changing and shaping of the face of the earth.
6. Understanding the meaning of the concept of time (in all of its implications).
7. Understanding the concept of energy and man's methods of utilizing it to serve his purposes.
8. Understanding the more important aspects of electricity and magnetism, the relationship between them, their importance to technology, scientific development and progress.
9. Developing an appreciation of the contributions which individual scientists have made to our civilization and society.

There were no laboratory periods for the course. Demonstrations were used as a means of helping the students to understand better certain physical principles.

Audio-visual aids (sound films) were used to help the students obtain a better understanding of the principles and concepts of physical science discussed in class.

There were three fifty-minute class periods each week for eighteen weeks.

Participation

The students who participated in this experiment were non-science majors. Thirty-six students were enrolled in the course. The majority of the students were sophomores (83%). The students were selected at random.

Method Employed

The procedure used in teaching the course was the lecture-discussion-demonstration method. The students were encouraged to ask questions and to make constructive contributions to the class discussion. Before each unit for class discussion, the students were furnished with an overview outline of the unit which was intended as a guide for the student's thinking and to channel his questions in the direction of the major topic being discussed.

The questions raised by the class were written on the blackboard by a student representative of the class, and the class grouped the questions into major problems for discussion and research.

The technique was designed to give students training toward the development of the ability to think scientifically.*

Tests and Treatment of Data

The tests used for the main purpose of this study were: Henmon-Nelson Tests of Mental Ability—Form B; National Achievement General Science Test—Form A; Comprehensive Examination in Physical Science—Factual Information Test—Forms 1 and 2; and a Comprehensive Examination In Physical Science—Scientific Thinking Test—Forms 1 and 2.

The Henmon-Nelson Tests of Mental Ability were used to determine the students' IQ range. The ages for the students who participated in this investigation ranged from 17 to 25 years. The IQ scores ranged from 70 to 118. The mean IQ score was 95.54.

The National Achievement General Science Test was used to ascertain the academic standing of the students in general science on the high school level. The scores ranged from 51 to 92.[1] The mean score was 69.11. The standard deviation was 9.592.

---

* The term scientific thinking as used in this study refers to the following procedures: (1) to recognize and state problems; (2) to select, evaluate, and apply information in relation to problems; (3) to recognize and evaluate conclusions, assumptions, and generalizations

[1] The maximum score was 120.

The Henmon-Nelson Tests of Mental Ability and the National Achievement General Science Test were administered at the beginning of the course.

The correlation coefficient between student scores on the Henmon-Nelson Tests of Mental Ability and the National Achievement General Science Test was .509. The formula used for computing the coefficient of correlation was the Pearson product-moment method.

The Comprehensive Examination in Physical Science-Factual Information Test—Forms 1 and 2 were constructed, by the writer, to measure overall achievements at the end of the first semester in the course.

The examination consisted of one hundred multiple choice items to answer. The items covered the factual information in the course. Students were allowed two hours of working time for each administration of Forms 1 and 2. Form 1 of the examination was administered at the beginning of the course, and Form 2 of the examination was administered at the end of the course.

Table I shows the frequency distribution of grades on the pre-test and post-test, mean scores, standard deviations, and the *t* ratio. It should be noted that the grades for the post-test were somewhat higher than the grades for the pre-test. The mean score for the post-test was higher than the mean score for the pre-test.

The Comprehensive Examination in Physical Science-Scientific Thinking Test—Form 1 and 2 was constructed, by the writer, to measure achievements in the understanding and use of the scientific method, at the end of the first semester of the course.

The examination consisted of four selections from scientific articles taken from current scientific journals and popular magazines, with twenty-five multiple choice items to answer. The questions were designed to determine whether or not the student understood and could use the steps in the scientific method.

Form 1 of the examination was administered at the beginning of the course and Form 2 of the examination was administered at the end of the course. Students were allowed one hour of working time for each administration of Form 1 and 2 of the Comprehensive Examination in Physical Science-Scientific Thinking Test. All examinations were administered and graded by the writer.

Table II shows the frequency distribution of grades on the pre-test and the post-test, mean scores, standard deviations, and the *t* ratio. The grade distribution for the post-test were higher than the grade distribution for the pre-test. The mean score for the post-test was somewhat higher than the mean score for the pre-test.

The value obtained for the *t* ratio is significant beyond the five per cent level of confidence. The null hypothesis of no difference be-

tween the pre-test and the post-test is rejected. On the basis of the statistical manipulations it appears safe to conclude that the teaching method used may have been significantly effective in the obtained results.

The coefficient of correlation between the students' scores on the Comprehensive Examination in Physical Science-Scientific Thinking Test, Form 1 and 2, was .53.

Results and Conclusions

The major findings of this study were:

1. The mean scores of the students on both the Comprehensive Examination in Physical Science-Factual Information was higher for the post-test than the mean scores for the pre-test. The statistical data in Table I show significant gains in the knowledge of factual information. From Table I, 41.65 per cent of the students raised their grade scores from the score range of 60–69 on the pre-test to the score range of 60–79 on the post-test. 88.87 per cent of the students on the pre-test had a score range of 20–49, but 19.44 per cent or less than one-fourth of the students had a score range of 20–49 on the post-test.

2. The problem-solving technique employed in the course designed to teach scientific thinking was apparently effective in teaching certain abilities associated with scientific thinking as described in the study. Table II shows that 30.54 per cent of the students raised their grade scores from the score range of 70–79 on the pre-test to the score range of 80–100 on the post-test. 55.53 per cent of the students on the pre-test had a score range of 20–49, whereas 27.77 per cent or one-half of the number cited above of the students on the post-test had a score range of 20–49.

3. The lecture-discussion-demonstration method as described in this study was effective, as indicated by the increase in grade scores and the mean scores for the post-test on the instruments used. The increase in individual grade scores on the Comprehensive Examination in Physical Science-Factual Information would suggest that the students made gains in the achievement of ascertaining factual information in the physical science course.

4. The ability to think scientifically, and the acquisition of factual information can be a concomitant outcome of physical science instruction. This implication appears justifiable in view of the gains made by the students on both the Comprehensive Examination in Physical Science-Factual Information and the Comprehensive Examination in Physical Science-Scientific Thinking Test.

Further studies of the method suggested here seem warranted.

TABLE I. FREQUENCY DISTRIBUTION OF GRADES, MEAN SCORES, STANDARD DEVIATIONS, AND THE *t* RATIO FOR THE COMPREHENSIVE EXAMINATION IN PHYSICAL SCIENCE—FACTUAL INFORMATION TEST-FORMS 1 AND 2

Pre-test (Form 1)					Post-test (Form 2)					*t* Ratio	
Grades*	Frequency	Per Cent	Mean Score	S.D.	Grades*	Frequency	Per Cent	Mean Score	S.D.	*t*† .01	*t*† Obtained
70–79	0	0.00	38.30	9.9	70–79	1	2.77	58	8.6	2.643	15.1
60–69	1	2.77			60–69	14	38.88				
50–59	3	8.33			50–59	14	38.88				
40–49	9	24.99			40–49	7	19.44				
30–39	19	52.77			30–39	0	0.00				
20–29	4	11.11			20–29	0	0.00				
Total	36	100			Total	36	100				

The value obtained for the *t* ratio was highly significant beyond the one per cent level of confidence. The null hypothesis of no difference between the pre-test and the post-test is confidently rejected. Hence, it is logical to assume that differences may be attributed to the teaching method used in this investigation.

* Scores were based on 100.

† Edwards, Allen L., *Experimental Design in Psychological Research*, Rinehart and Company, Inc., New York, 1950, pp. 151–152.

TABLE II. FREQUENCY DISTRIBUTION OF GRADES, MEAN SCORES, STANDARD DEVIATIONS, AND THE *t* RATIO FOR THE COMPREHENSIVE EXAMINATION IN PHYSICAL SCIENCE-SCIENTIFIC THINKING TEST—FORM 1 AND 2

Pre-test (Form 1)					Post-test (Form 2)					*t* Ratio	
Grades*	Frequency	Per Cent	Mean Score	S.D.	Grades*	Frequency	Per Cent	Mean Score	S.D.	*t*† .05	*t*† Obtained
90–100	0	0.00	50.72	12.41	90–100	5	13.88	64.72	19.34	1.992	2.02
80–89	0	0.00			80–89	6	16.66				
70–79	4	11.11			70–79	3	8.33				
60–69	5	13.88			60–69	9	24.99				
50–59	7	19.44			50–59	3	8.33				
40–49	14	38.88			40–49	7	19.44				
30–39	5	13.88			30–39	3	8.33				
20–29	1	2.77			20–29	0	0.00				
Total	36	100			Total	36	100				

* Scores were based on 100.

† Edwards, Allen L., *Experimental Design in Psychological Research*, Rinehart and Company, Inc., New York, 1950, pp. 151–152.

Reversible lens for eight-millimeter movie cameras enables the user to take wide-angle or telephoto pictures, depending on which side of the lens is toward the camera. This unique lens is color corrected.

TRAINING MEN FOR INDUSTRY

JOHN SIEGER

Supervisor, Training Section, Engine and Foundry Division, Ford Motor Company, 3000 Schaefer Road, Dearborn, Michigan

Almost everyone likes to discuss his own job and I'm no exception. We in industry get a lot of satisfaction from the part we play in promoting American progress, but we never forget that you people in the industrial education field do a big part of the job of developing ability and initiative in the young men who become skilled workers and leaders in our plants. And no doubt, you get a lot of satisfaction out of the fine job you're doing.

I'd like to spend some time telling you about the kind of men we need now, and we're going to need more of, for the plants of the future. After all, you're going to do the early training of these men. We employ a lot of men with a variety of skills to operate and maintain the machines and equipment in these so-called "automatic" plants. They are in our new Cleveland and Dearborn Engine Plants where we manufacture the overhead valve engines for the Ford, Lincoln and Mercury. We do not have automatic plants, but we have installed a production system in these plants that we call "automation." It takes work off man's back and puts it on a machine. As a result we can produce more with less effort. It is part of the broad pattern of American progress—of producing more with less effort so that we will have more. Yes, we still use a lot of men in these plants. The jobs no longer involve back-breaking labor, but they do require greater skill. More and more men have the opportunity to become skilled craftsmen—to fill new jobs—designing, managing, and servicing huge expensive machines and equipment. We are very often asked the question: "What is the difference between ratio of skilled to unskilled employees under the old sytem of manufacturing as compared with automation?"—That is a difficult question to answer with any degree of accuracy. This comes about because when you are considering the number of skilled men involved, you cannot only count noses in your own plant or plants, but you must also consider the increase in number of men going into Tool and Die Plants and into various machine and tool companies, organizations who build and assist in the servicing of the machines and equipment. This is evidenced by the difficulty in obtaining the services of highly skilled workmen and engineers. I can answer the question to this extent—there has been a definite increase in the ratio of skilled to unskilled employees and it is expected that as time

goes on this trend will continue. There will be greater need for more and more skilled men such as electricians, tool and die, hydraulics, millwrights, etc.

Let me give you some examples of *the skills* required to keep these automated production lines going. Electronic "brains" provide a lot of the control. They consist of dozens of control panels, all interrelated. Some have as much as 25 miles of wire in their hook-up plus a large number of switches and relays. These are the mechanical brains of the production line, but they won't operate very long without the guidance of skilled men.

We have tool control boards, the last word in preventive maintenance. These boards count the number of times a tool has been used and flash a warning when it is time to change the tool. If the warning is ignored for a predetermined length of time, the board automatically shuts the machine down. But don't forget that men are required to operate these boards and the tools must be pre-set and changed.

As production processes become more complicated, the demand for skilled workmen increases. The Engine and Foundry Division is helping to develop that skill. We have organized and are presenting a series of training programs designed to get the journeyman up to date and keep him there.

The programs are primarily directed toward machine operators, maintenance men, and supervisors and are intended to broaden the skills and increase the effectiveness of all personnel concerned with machine operation. The courses are coordinated by technical training specialists from the company working in conjunction with vendors and the men who engineered and built the machines now in use.

At this time there are four training programs in operation—each designed to develop a higher skill in operation and maintenance. The courses include:

1. Familiarization on All Machines
2. Tool Control Board
3. Hydraulics
4. Central Lubrication Systems

A similar approach is being developed for electronics equipment. In addition to this formal training, we cannot forget the thousands of hours that are spent by supervisors in training their people.

Automation is a new word—a new word to describe an old idea; the transfer of work from the man to the machine. The basic problems connected with this transfer is not new either. Ever since James Watt succeeded in harnessing 18th Century Steam, viewers with alarm have worried about man's eventual replacement by machines. It was a pessimistic possibility in 1800. In 1955 the same gloomy

view persists in certain quarters. But American ingenuity handled the problem then; it is handling it now.

In addition to a wide variety of skills, men who fill future jobs will have a greater need for *good work habits*. They will use more complicated, more expensive machinery and equipment—production tools that are larger, heavier, more powerful. As a result, operators will need a well developed habit of alertness—be able to feel the pulse of these automatic giants—know how their machine controls fit into the over-all pattern of hundreds of other machines that make up the entire manufacturing and assembly line—understand what happens if the controls are not handled properly. Let me point out one fact—automatic machines are nothing but mechanical morons without man's mental and manual skills. *Maintenance* men will need the habit of keeping moving parts cleaned and well lubricated, of checking and double checking, and checking again—of spotting trouble before it happens. A serious breakdown on an automated line may shut down the entire plant. Men will be out of work and costs will shoot upward.

Men who wish to be supervisors will need the habit of always working by plan. Hit-or-miss activities will not last long in a modern factory. Present and potential supervisors will need a greater knowledge of the equipment under their jurisdiction. The people under their supervision will be of higher skill and will require more training in the operation and maintenance of this complicated equipment. Supervisors will have to train employees in the safe operation of the equipment because one button pushed at the wrong time may injure employees before the operator knows what has happened.

Flexible skills and good work habits are most essential—but we need more than skill and good work habits if we are going to continue progress, the kind of progress that has made America the leading producer of the world—we need men with *forward looking attitudes*. Competiton—cooperation. They are just words. But meshed into the lives of men, they become dynamic forces—power that promotes the best, both in individual and in group efforts.

The *competitive spirit* shows up in the man who is continually looking for a better way—who knows that one cent knocked off per car means a ten-thousand-dollar saving on production of a million cars—who shows his desire for the new and better by reading, studying, and observing.

Cooperation is another much needed attitude. It should go hand in hand with competition, otherwise we may forget that group and company progress determine individual progress. Even the best workman can't go forward in a company that is backing up.

The big question is how can we promote a spirit of competition

along with cooperation. One of the basic requirements is *an understanding* of what the free enterprise system is all about. The young men that we need for tomorrow's job should know about—

Our *natural resources*, the new materials we now have, what we have to import, and how important it is to conserve our supplies.

They should understand our freedoms, what they are, how we got them and the importance of protecting them—else we may lose them.

They should be aware of America's vast educational facilities. The abundance of libraries in our country. The churches for every creed. They should know the services that these institutions provide and how to participate in their activities.

They should appreciate the importance of *capital goods* in economic progress—the expensive and time-saving plants and machinery and railroads and power facilities that make it possible for us to produce 45% of the world's goods and services with only 7% of the population. And how investors risk their savings to provide these capital goods. And what the role of profit is in promoting a steady flow of capital investment—

Into new plants
Into modernization and expansion projects
Into research for the new and better.

They should know how the long range increase in *productivity* has resulted in *more jobs*—not less. How the work week has been cut by one-third in the last eighty years. How the *output per man-hour* has gone up 500% in the same period.

We are confident that men who have this basic understanding of our economy will make better citizens. They will vote and spend and save and invest in a way that promotes over-all American progress. They will be able to read the ever-changing newspaper reports with a discerning eye. The stock market is rising, then it's falling. That business is going up, sales start falling off. We are preparing for war, we hope for peace. What's happening? Is it a picture of discord? Of a nation that can't move because it can't make up its mind? Or is it the outward sign of a vigorous, dynamic nation—of free people who compete for individual goals, but cooperate for group progress.

We get the right picture when we understand our free enterprise system—what we have accomplished with it—how we did it—and what we can do in the future. That is quite a large order, I realize.

We need young men with flexible skills, good work habits, progressive attitudes, and a basic understanding of free enterprise. We are working on these problems at our end; and we know you're doing the same, as your time permits. In any event, we have need for young

men with those qualifications. They will become the leaders of industry.

PROOF IN ADDITION BY LATERAL ADDITION

VALLY L. JOHNSON
Sue Ross State College, Alpine, Texas

Casting out nines or proof by nines, as discussed in an article in the March issue of SCHOOL SCIENCE AND MATHEMATICS, is a wonderful boon to arithmetic. Children have a natural like for puzzles. From observing children using this technique of checking arithmetic it can readily be seen that it is as interesting to them as their favorite puzzle.

Casting out the nines is a very effective way of checking problems but is slightly complicated for many of the children in the elementary school. As was pointed out in the March issue, the same results will be achieved if you add all the digits to a one digit total not dropping the nines. This can also be called lateral addition. This method is much simpler and can be taught to children in the elementary school several years earlier than casting out 9's.

Lateral addition is very effective in checking addition and can be taught by the time the child learns to add three or four digit columns of numbers. The following problem illustrates this:

$$\begin{array}{r} 43256 = 20 = 2 \\ 12382 = 16 = 7 \\ 89634 = 30 = 3 \\ 78921 = 27 = 9 \\ 68975 = 35 = 8 \\ \hline 292268 \qquad 29 = 11 = 2 \\ \downarrow \\ 29 = 11 = 2 \end{array}$$

The procedure in this problem was to think:

4+3+2+5+6 equals 20, and 2+0=2
1+2+3+8+2 equals 16, and 1+6=7
8+9+6+3+4 equals 30, and 3+0=3
7+8+9+2+1 equals 27, and 2+7=9
6+8+9+7+5 equals 35, and 3+5=8

The next step is to total the last column of figures and reduce to one digit, thus:

2+7+3+9+8 equals 29, then 2+9 equals 11, then 1+1 equals 2.

Next reduce the sum of the problem to one digit by lateral addition, thus,

2+9+2+2+6+8 equals 29 and 2+9 equals 11, then 1+1 equals 2.

When the one digit numbers of the addend have been totaled and reduced to one digit by lateral addition, and the sum of the problem has been reduced to one digit by lateral addition the problem is checked as correct if these numbers are the same, as proved by the two 2's in the problem which is given as an illustration.

Not only does this give the children an interesting means of checking their problems, but it also gives extensive drill in addition, and in a way in which the children enjoy the drill.

THE SCIENCE FAIR IN MINNESOTA

LEONARD A. FORD
State Teachers College, Mankato, Minnesota

A bespectacled Minneapolis high school senior, David Cahlander, won first place award for the best exhibit in physics at the southern Minnesota science fair held at Mankato State Teachers College on April 16, 1955. Two weeks later his exhibit won the Croxton award for the best science exhibit in culmination of the two-day Minnesota state junior and senior Academy of Science convention also held at Mankato.

Cahlander's exhibit entitled "Electronics for greater versatility in photography" included a sound controlled flash for taking photographs, a radio controlled flash, a repeating strobe unit and a light beam strobe which, when broken, snapped the shutter of the camera. As a result of his interest and ability, Cahlander has since been awarded a $1000 scholarship at Massachusetts Institute of Technology.

David Cahlander's exhibit was one of hundreds presented by Minnesota high school boys and girls at the five regional science fairs and the state-wide junior Academy of Science fair. Thousands of students and their science teachers came to these fairs which have become annual events and have had a decided impact on science teaching in almost all schools of the state.

Science fairs are annual events held in April at the State Teachers Colleges in Mankato, Winona, St. Cloud and Bemidji and at Duluth Branch-University of Minnesota. Coordinator of all the fairs is Dr. Edward Baldes, inventor of the human centrifuge for testing flying suits. Dr. Baldes, biophysicist at the Mayo Foundation has a keen interest in development of young scientists. As Vice-President of the Minnesota Academy of Science, he works closely with the Junior Academy and its forty high school chapters.

The St. Cloud fair, called a science congress, drew entries from 14 high schools in central Minnesota. Donald Clausen of Washington Junior high school, Fergus Falls, won first prize in the general science division for his telescope and Newtonian reflector. In its fifth year, the fair has been sponsored by the College Academy of science and the science teachers of central Minnesota. Hundreds of students and teachers were in attendance as the award winners explained their exhibits.

The fifteenth annual science day at Winona State Teachers College was attended by two thousand students from many Minnesota and Wisconsin communities. Sponsored by the college science clubs and

Mayo Foundation of Sigma Xi, the fair included exhibits by the college science departments, local industries, the Mayo Foundation as well as high school students. First place award went to John Ramsden, Winona Cotter high school, for his display on the care of apples. The 36 scientific displays and demonstrations included all the phases of science and mathematics.

David Cahlander receiving the Croxton Award from Dr. William Marshall.

The junior academy of science meeting held in conjunction with the Minnesota senior Academy of Science brings together annually student scientists and their teachers from the entire state. The competition among exhibitors at this event is so keen that the judges

have difficulty in deciding among the extraordinary exhibits. The 1955 meeting held at Mankato brought hundreds of young scientists from such towns as Albert Lea and Bemidji. Judging by the 19 college professors and industrial scientists was difficult since many of the high school exhibitors showed ability and understanding far surpassing the work of average college students.

The Minnesota Academy of Science membership, together with scientists in Minnesota industries, have been seriously concerned with the growing shortage of scientists. A scholarship fund, financed by industry and administered by the Academy, has made it possible to give seventeen $200 scholarships to outstanding high school seniors.

The shortage of qualified students in engineering, medicine, highly technical fields and in science teaching has aroused members of the Minnesota Academy of Science to carry out a statewide program of action. Science fairs have inspired hundreds of Minnesota youth to work on exhibits and demonstrations. The science and arts building at Mankato State Teachers College was teeming with the activity of over a thousand young scientists in April at the fourth annual science fair. Among the three hundred exhibits and demonstrations on display were "Spike, the Mechanical Dog and His Master," exhibited by Harry Tryon of Redwood Falls and a crankshaftless engine in the physics section, by Robert Mensch, a student at Welcome high school. Winners were judged by a panel of twenty scientists selected from industry and education. Awards totaling over $300 were given to 42 winners from 17 schools with funds donated by industries interested in encouraging young scientists.

At the Bemidji fair more than 175 people were in attendance to see 44 exhibits covering a variety of scientific subjects. High schools from as far away as Middle River, Crookston and Longville demonstrated their own exhibits and admired those of others. Winning first place in physics was Robert Buus of Crookston who showed a microwave transmitter and receiver. Dale Dickenson of Bemidji won first place in chemistry with his exhibit on the making of cellophane.

The Duluth fair with attendance from the northern part of the state saw Gary Freeman, a Cloquet high school junior win top prize for his exhibit in general science entitled "Science Versus Crime." Bacon and eggs were fried with light rays, sample explosions rocked the rooms, pin wheels whirled under electric spark power as UMD's first annual science exposition drew hundreds of participants and spectators.

Efforts of the Minnesota Academy of Science which has been headed by Dr. Leonard A. Ford, State Teachers College, Mankato during the last year has been directed to creating a greater interest

in science in Minnesota schools. Dr. William Marshall, Institute of Agriculture, University of Minnesota, who has been responsible for obtaining funds for the industry-scholarship program assumes leadership of the organization for 1955–1956. Dr. Blanchard Krogstad, University of Minnesota at Duluth is secretary-treasurer.

PHYSICS OR THE MISUSE OF MATHEMATICS

WILLIAM H. DANNACHER
Valley Forge Military Academy, Wayne, Pennsylvania

I have been convinced for some time that many students finish their course in high school physics with fading memories of facts and formulas and with little understanding of the principles and laws from which the formulas were derived. This restriction to high school students is probably not justified, as there are undoubtedly many college students with the same impressions. It is a frustrating experience for the physics teacher to be confronted with a question from one of his students just before the final examination such as: "If I know all the formulas and can work all the problems assigned for review, will I be able to pass the test?" Clearly this student had little concept of the basic principles in physics. The memorization of formulas and the ability to substitute numerical data for letters is surely no criterion for success in the course.

The authors of today's elementary physics texts appear to be conscious of this situation and to exercise considerable care in the presentation of their material. Their lot is not an easy one, however. To strip a text of algebraic symbols and to permit the student to work from principle to problem (or problem to principle) is not always feasible or desirable. For example, the concept of resonance in an electric circuit, containing both inductance and capacitance, can best be expressed and understood by mathematical symbols. The same is true of many ideas in physics. In addition, the tools of mathematics allow us to express our ideas clearly and often lead us to recognize new relationships that were not evident when the original principle was first expressed in words. This is good and desirable. The proper use of formulating ideas is certainly one of the objectives every physics teacher should try to achieve. The point I am trying to make is that *use* and not *misuse* of mathematics must be emphasized. An idea expressed in naked algebraic symbols and called a formula is often used as a substitute for reasoning by many students.

In order to encourage the students to reason, the teacher must constantly and consciously emphasize basic principles rather than formulas. After this is done, the teacher can then point out to the

students that formulas are really nothing more than convenient methods of expressing ideas. A simple illustration should follow this remark. For example: "The circumference of a circle varies directly as the diameter. In symbols, $C \propto D$, and as an equation, $C = kD$. If the constant is determined empirically, we would recognize it as our old friend, π. In expressing ideas symbolically in physics, constants so determined may be unfamiliar. We are grateful for the notation of mathematics, but we must be careful to remember the principle first and the notation second."

An excellent opportunity to proceed directly from principle to problem awaits the class when studying the mathematics of fluids. It is a common experience among teachers of elementary physics that one of the most difficult laws for students to understand thoroughly is Archimedes' Principle. This principle can be stated in several equivalent ways, one of which is as follows: "An object immersed in a fluid is buoyed up by a force equal to the weight of the displaced fluid." The subtle beauty of this principle reveals itself to the student who is willing to make a careful analysis of it, and it is impossible for the careless student to find an easy formula to take its place. The careful student will note that the words "immersed" and "fluid" are used so that the generality of the statement is preserved. The derivation of Archimedes' Principle is relatively simple and affords the students an opportunity to gain an insight into the proper use of mathematics as a tool in studying physics.

The student who has been taught to analyze a particular problem in terms of fundamental principles has definite advantages over one who is concerned only with finding the right formula quickly as a panacea for his immediate troubles. We sometimes hear the criticism that we are failing to teach our students how to think. The validity of this statement is debatable, but we may at times be guilty of not insisting that they understand. In the final analysis, there is no formal substitute for thinking.

SEVENTH ICTM ANNUAL CONFERENCE

The seventh Annual Conference of the Illinois Council of Teachers of Mathematics will be held at the University of Illinois, Urbana, Illinois, on Saturday, October 8, 1955 at 9:30. Dr. John R. Clark, Professor Emeritus, Teachers College, Columbia University will address the Elementary Section on "Teaching of Important Meanings of Arithmetic" and Dr. William L. Duren, Tulane University and president of the Mathematical Association of America will address the Secondary and College Section on the topic "Toward a Reconstruction of High School Mathematics." At a joint session at 1:30 P.M., Dr. Clark will speak on "The Role of Thinking in Mathematical Learning." For further details and information contact Dr. Francis R. Brown, Illinois State Normal University, Normal, Illinois.

A STYLE FORM GUIDE FOR TYPEWRITTEN MATHEMATICAL MANUSCRIPTS

CECIL B. READ

University of Wichita, Wichita, Kansas, Mathematics Editor, School Science and Mathematics

The author who is preparing mathematical manuscript discovers quickly that the typing of such material involves many problems. For a relatively small charge, any typewriter repair shop can substitute a key with the symbols + and = for some key less frequently used. If a new machine is being purchased, additional substitutions may well be considered, or one may obtain a special keyboard, such as an "engineering" or "mathematical" keyboard; these may or may not suit the particular needs of the purchaser. Often, however, the standard mathematical keyboard is all that is available.

The author of this article has seen many different typewritten manuscripts which involve mathematical symbolism: school tests; articles submitted to SCHOOL SCIENCE AND MATHEMATICS for publication; master's theses; texts, manuals and the like. Some are original copies, others are produced by mimeograph, spirit duplicator, or photographic process from typewritten copy. The quality and legibility of such manuscripts varies widely, in fact some material submitted for publication is either illegible or almost incomprehensible. Many could be improved with relatively little effort.

References are available which offer suggestions to authors submitting manuscript to the printer[1] and these offer some help. Material prepared for the printer, however, will eventually have available much more flexibility than the ordinary typewriter provides, for example, various widths of horizontal spacing and varying sizes of type.

This brief style form guide has been prepared with the idea that it may be helpful to those typing mathematical copy which in many cases will never appear in print. In its preparation, material in the references cited was used when applicable, and a study was made of current practice in printed texts and periodicals. There is definite evidence of minor differences between various publishers, but in general one finds uniformity throughout any book or article. Deliberately the guide is restricted to material which would normally be encountered in courses at the level of calculus or lower, and to the

[1] T. W. Chaundy, P. R. Barrett, and Charles Batey, The Printing of Mathematics (Oxford University Press, 1954).

Typographic Suggestions to Authors, prepared by George Banta Publishing Company, Menasha, Wis. (No date).

Mathematics in Type, (The William Byrd Press, Richmond, Va., 1954).

Manual for Authors of Mathematical Papers, *Bulletin of the American Mathematical Society*, Vol. 49, Number 3, part 2, (March, 1943).

situation where very few if any symbols have been added to the standard mathematical keyboard.

Primarily this guide is concerned with material which is in its final form to be typewritten, nevertheless a properly typed manuscript will not handicap the printer should it be accepted for publication. For material not destined for the printing press, uniformity and legibility are certainly to be desired, and above all the reader should be able to understand the notation used. Even if the author chooses to use other forms than those suggested, this does not excuse a lack of consistency; if the product of a by the sum of x and b is to be used, it is hard to see why in one line it appears as $a(x+b)$, in another line as $a(x + b)$, again as $a\ (x+b)$, or even as $a\ (x +b)$. Yet these identical variations are in a manuscript now in the hands of the writer. Whatever forms are adopted, the usage should be consistent throughout the article.

One word of warning is necessary: If manuscript is submitted to a typist not thoroughly familiar with mathematical symbolism, it must be very carefully checked; otherwise such expressions as $|2|$ may appear as 121, a Greek letter omega may become an English w, $\cos^2 x$ may be typed as $\cos 2x$, or a' may be changed to a^1.

It is a very rare situation indeed in which double spacing is not preferable. If one line of the text involves subscripts and the next line involves exponents, triple spacing may be advisable for these lines. Preferably formulas which require such uneven spacing should appear as displayed material rather than in solid text. Do not crowd displayed material.

Choice of symbols or letters: In general in typed manuscript one should avoid if at all possible the use of lower case letter "ell," since this letter when typewritten is used for the numeral one. For similar reasons the capital letter O is to be avoided because of confusion with the numeral zero.

Make maximum use of characters on the typewriter, not only to avoid waste of time and possible omissions when inserting symbols by hand, but because symbols written by hand may vary greatly and cause confusion. In many cases a replacement such as $\cos (x + y)$ for $\cos (\alpha + \beta)$ is entirely feasible.

Although it is possible to type such symbols as $\dot{x}$, $\bar{x}$, etc., in many cases it would be possible to use x', x'', or x_2 equally well. The first two and probably the third of the suggested alternatives can be produced more rapidly.

Fractions: The use of the solidus will keep a fraction in a single line. It is certainly faster to type a/b rather than $\frac{a}{b}$, however, as in tests,

one needs to be sure that the reader is familiar with the meaning of a/b. There must be no possible ambiguity, the writer may know that $a/b + x$ is not $a/(b + x)$ but to avoid any confusion it is best, if the solidus is to be used, to write $x + a/b$. One may conserve space by typing

$$\frac{(a+b)/(c+d)+(a-b)/(c-d)}{p+q-r/s} \quad \text{rather than} \quad \frac{\dfrac{a+b}{c+d}+\dfrac{a-b}{c-d}}{p+q-\dfrac{r}{s}}$$

but in certain situations there may be definite reasons for use of the second form.

With certain functional symbols care is needed; for example $\sin y/k$ may by one reader be understood as $\sin (y/k)$; by another as $(\sin y)/k$. The parenthesis should be used, or an unambiguous notation such as $\dfrac{\sin y}{k}$ or $\sin \dfrac{y}{k}$.

It is in general not necessary to use either a dot, parenthesis, or a cross to indicate the product of separate fractions, thus we type $\dfrac{a}{b}\,\dfrac{m-x}{m+x}$, rather than $\dfrac{a}{b}\cdot\dfrac{m-x}{m+x}$ or $\dfrac{a}{b}\left(\dfrac{m-x}{m+x}\right)$. In some cases there is no loss in combining into a single fraction, as $\dfrac{a(m-x)}{b(m+x)}$.

In a compound fraction the printer makes the bar or rule separating the main fraction thicker; this is not feasible in typed copy but if there is possibility of confusion and for any reason the solidus is not to be used, the main bar of the fraction should be made longer, as for example

$$\cfrac{\dfrac{x+y}{a+b}}{\dfrac{p}{r-m}}.$$

Exponents: In general, the solidus is used for fractional exponents. $x^{a/2}$ is certainly easier and faster to type (and probably better understood than $x^{\frac{a}{2}}$. An exponent affecting a letter with a subscript may be typed as $(x_3)^2$ rather than x_3^2; however, considerations other than those of typing may dictate the form to be used.

Exponents which themselves involve exponents may often be avoided; one may instead of a^{k^2+1} write a^r where $r = k^2 + 1$. In advanced work the use of exp (k) for e^k is quite common. Thus exp $(\cos x + i \sin x)$ is used in place of $e^{\cos x + i \sin x}$. Whether this is preferable in an individual situation may depend upon several factors.

Radicals: Although printers dislike to use the bar or vinculum, practice (at least in the United States) seems to favor $\sqrt{2}$ rather than $\sqrt{2}$, and certainly $\sqrt{a+b}$ rather than $\sqrt{(a+b)}$. Fractional exponents may be of value, for it is easier to type $\left(\frac{a^2 - 2b^{\frac{1}{2}}}{a+b^2}\right)^{\frac{1}{2}}$ than to use the alternative notation which involves radicals.

Symbols of Grouping: Normally, the typewriter keyboard will only provide parentheses, other symbols such as brackets and braces must be inserted by hand. A little planning may eliminate the need for a second set of symbols of grouping. Even when details seem necessary, one might write:

If we let $m = a(x - a) - x(a + x) = -a^2 - x^2 = -(a^2 + x^2)$,

then $\sin(-m) = \sin(a^2 + x^2)$.

This seems to avoid the use of braces and brackets, as in

$$\sin\{-[a(x-a) - x(a+x)]\} = \sin(a^2 + x^2).$$

As was pointed out, to avoid confusion, instead of $\tan x + a$ we may write $\tan(x) + a$, or better, $a + \tan x$. A recent book prints $\sin x(\cot x + \csc x)$. One is not sure what is intended. Along the same line, it is preferable to write $x\sqrt{a}$ rather than $\sqrt{a}\,x$; likewise $a \sin x + b \cos y$ rather than $\sin x\, a + \cos y\, b$ (if for some reason the latter order seems imperative, parentheses must be used).

Abbreviations: Technically such expressions as sin, cos, log, ln, mod, etc., are *symbols*, and not abbreviations. As such, they are written without a period, and *never alone*. Thus we may write $\cos x$; $\tan 45°$; $\log 7$; but *not* the tan of the angle, or cos=0.707, or log=0.3010. On the other hand, standard abbreviations such as ft., yd., e.g., i.e., etc., are used as in ordinary writing.

Temporary symbols or expressions: Sometimes it is helpful to introduce a new symbol, letter, or expression for the purpose of brevity or clarity. The complexity of an equation may be reduced by defining $t = x^3 + y^3 + z^3$. Normally the substitution is made the first time the expression occurs; in some situations the original expression may be used during a development and then the new definition introduced, particularly if later work will be simplified by the new symbol. In a lengthy article, particularly if a non-standard symbol is introduced, reference to the definition may be helpful when the symbol is again

employed. In any event before introducing a new symbol, be sure that this is done for reasons other than mere novelty or temporary convenience.

Punctuation: A very common error is to omit the period at the end of a sentence which ends with a displayed mathematical formula or equation, such as

$$3x - 2y = 7.$$

When a period or comma follows a fraction, it is properly placed in line with the main bar of the fraction, i.e., $\frac{x+y}{k-r}$.

Commas are proper in connection with mathematical expressions, even when in displayed form, for example:

From the equations

$$\begin{aligned} x + y + z &= 6 \\ 3x + y - z &= 2 \\ 2x + 4y + z &= 11 \end{aligned}$$

we obtain $x = 1, y = 2, z = 3$.

A comma may be needed to separate a number from a symbol, as for example in the reference: From page 3, $y = 7$.

Many authorities state that in solid text a sentence should never begin with a mathematical symbol.

Identification for purposes of reference: Displayed equations or formulas may be accompanied by a number or letter for reference purposes; however, an equation or formula should be numbered only if it is to be referred to elsewhere. The reference number or letter should be enclosed in parentheses, and for uniformity, should always appear in the same position. This position may be at the extreme left margin, or uniformly indented from the margin. If the displayed material is on one line, the reference number appears on the same line, if the material occupies two or more lines, the reference number is centered.

Examples:

(53) $(a + b)^2 = a^2 + 2ab + b^2$

By definition, if $a + bi = c + di$,

(35.2) then $a = c$, $b = d$.

(XI) $$(a + z)^{11} = a^{11} + 11a^{10}z + 55a^9z^2 + 165a^8z^3 + 330a^7z^4 + 462a^6z^5 + 462a^5z^6 + 330a^4z^7 + 165a^3z^8 + \cdots.$$

Footnotes: Since numerical figures may in some cases cause confusion, footnotes may be indicated by the asterisk (avoid this if it is used as a mathematical symbol), the # sign, or some other of the symbols on the standard keyboard which are not being used in the particular manuscript. References to published material may be in any standard form, if uniformity is maintained.

Suggestions for the Typist

The preceding material, although perhaps helpful to the typist, is of primary use in the preparation of copy. The suggestions which follow are of particular value to the typist who is trying to prepare a final draft which is legible, understandable, and in a uniform style. *Symbols not on the keyboard:* The lack of many standard mathematical symbols is a real problem. In many cases considerable ingenuity is needed. On most typewriters striking the hyphen over the zero produces a good Greek letter theta; the solidus and the letter o (or the zero) makes a phi; the underline and the solidus make a good angle symbol, $\angle$, but this is *not* a satisfactory substitute for the "less than" symbol. The hyphen struck over the solidus is *not* a satisfactory substitute for plus, nor is a repetition of the solidus (//) a standard symbol for "is parallel to."

If a large summation symbol is needed, the underline (repeated two lines below) combined with the solidus produces all of the symbol with the exception of one diagonal line; moreover, the underlines are in a position to make the insertion of subscripts feasible. If one is fortunate enough to possess a typewriter with a vertical bar, the product symbol (capital Greek Pi) is readily produced; combining the underline with the capital letter I does not prove too satisfactory in this case.

The underline and a plus symbol (if the latter is available) are combined for $\pm$; the variable line spacer produces exponents (and a degree symbol by use of the lower case letter o). In many cases, in the interest of clarity, it is better to insert characters with the pen (or stylus for mimeograph work) than to risk illegibility or misunderstanding. Generally the colon struck over the hyphen does *not* produce a good division sign, since it is confused with the plus symbol; the apostrophe struck over the minus sign is satisfactory for neither the plus sign or the perpendicular symbol in geometry. A recent manuscript submitted for publication used the apostrophe written above a subscript numeral two as a means of writing the fraction one-half. The absence of the fraction bar and the small size of the numeral made it difficult to decide just what was intended.

If the keyboard contains certain fractions, such as $\frac{1}{2}$, we normally

write $\frac{1}{2}\log x$ rather than $(\log x)/2$ or $\frac{\log x}{2}$. However, if in the same expression we need to write $\frac{1}{2}$ (on our keyboard) and $2/3$ (not on our keyboard), for uniformity we type $\frac{1}{2}\log x + \frac{2}{3}x$ or $\frac{\log x}{2} + \frac{2x}{3}$ and *not* $\frac{1}{2}\log x + \frac{2}{3}x$. Likewise we would type $\frac{1}{2} + \frac{2}{3}$ rather than $\frac{1}{2} + \frac{2}{3}$.

When symbols are inserted by pen, they should be the same size as the typed material, except in cases of a parenthesis around a fraction, etc.

Radical signs: When the radicand involves exponents certain typing difficulties are involved, for unless the line of writing is lowered, the bar will run through the exponent. An expression such as $\sqrt{a+b^2}$ should be avoided as ambiguous. If the typist is fortunate enough to have a radical sign on the typewriter, it may be that the solidus can be used to provide a "two-story" radical sign, such as $\sqrt{\frac{a+b}{a-b}}$.

If a radical appears in the denominator of a fraction, the variable line spacer is employed to avoid confusion of the fraction bar with the vinculum of the radical; if in addition exponents are in the radicand, the variable line spacer again comes into play. Nevertheless, with a little time and care, one can type such expressions as

$$\frac{\sqrt{a+\sqrt{b}}}{\sqrt{a^2+b^2}}.$$

Typing exponents and subscripts: One frequently sees "sloppy" copy in which the exponents in a single line of material are very appreciably out of alignment. With a standard keyboard typed exponents are usually produced by moving the typewriter platen or roller to change the line of writing. Greater uniformity will be obtained if, instead of inserting each exponent as it is reached in the copy, the entire line is typed, leaving space for the exponents, then with the variable line spacing device, the line of writing is changed once, and all exponents in the line of copy are inserted. Care is needed to see that none are omitted, and proof reading is needed.

Fractions: The rule for a fraction or radical sign should extend as far as, but not beyond, the final symbol involved.

Examples: $\frac{a}{b}$ $\frac{a+b}{c}$ $\frac{a+b^2}{mn}$ $\frac{a}{\sin A}$ $\sqrt{x^2+y^2}$

however $\dfrac{y}{\dfrac{a+b}{c}}$ where the longer line indicates the main bar for the fraction.

Use no space:

Between symbols indicating or representing a product.

Examples: $3\sqrt{x}$ $2y$ $5mn$ $6n^2q$ $a+(n-1)d$ $(x+y)(a-b)$

To separate parentheses, brackets, or absolute value signs from the quantity involved.

Examples: $(a+b)$ $2[m-n]$ $|x|$

Between the numerator and denominator of a fraction when these are separated by a solidus.

Examples: a/b $4y-3/x$ $(a+b)/(2+x^2)$

Between a radical sign and the first term of the radicand.

Examples: $\sqrt{x}$ $\sqrt{k-r}$ $\sqrt[3]{\sqrt{a+by}}$

Between a quantity and an exponent, subscript, or prime.

Examples: x^2 $(a+b)^5$ a_0 $f'(x)$ a^{-n} e^{x^2} $(a^m)^{-n}$ $\log_{10}$

NOTE: If it is necessary to use both an exponent and a subscript, the exponent is placed directly over the subscript.

Examples: a_2^3 b_n^{k-r} c_{n+r}^s a_{n+2}^{s+1} a_2^3 b_n^{k-n}

Between the coordinates of a point or between a letter representing a point and its coordinates.

Examples: (x,y) $(1,3,4)$ $(-2,0)$ $(2,45°)$ $P(x,y)$ $P_2(x_2,y_2)$

After $\angle$, $\triangle$, $\odot$, etc., in geometrical notation.

Examples: $\angle x$ $\triangle ABC$ $\odot ABCDE$ $\angle MTI$

Between a quantity and the factorial symbol.

Examples: $3!$ $(2n-1)!$

In the functional notation symbolism.

Examples: $f(x)=x^2$ $3f(x)$ $f(-1)$ $f(a+b)$ $f_{xx}(x,y)$ $\phi(z)$

Between an integral sign and the limits of integration.

Examples: $\int_{a}^{b}$ $\int_{-1}^{-2} x^{3/2}\,dx$

NOTE: In the printing of an integral sign the lower limit will be slightly to the left of the upper limit, hence if the integral sign is to be inserted by hand, the lower limit may be typed one space before the upper limit. If the typewriter keyboard has an integral sign, the upper limit will fall directly above the lower limit.

Between Δ (delta) and the quantity affected.

Examples: $y + \Delta y = f(x + \Delta x)$ $\lim_{x \to 0} \frac{\Delta y}{\Delta x}$

Before or after D_x or $\frac{d}{dx}$ indicating a derivative.

Examples: $D_x x^4 = 3x^3$ $D_x G(x) = f(x)$ $D_x u = nu^{n-1} D_x u$

$\frac{dy}{dx}$ or dy/dx $\frac{d}{dx} e^u = e \frac{du}{dx}$ or $\frac{de^u}{dx} = e^u \frac{du}{dx}$

Use one space:

Before and after the symbols $+$, $-$, $\div$, $\times$, $\pm$, $\mp$.

Examples: $x - y$ $3(a + b)$ $\frac{m}{n} - \frac{a + b}{am - k}$ $PQ \times RL$

NOTE: Some authorities specify *no space* before and after these symbols. Whichever standard is followed, be consistent.

Exception 1: Omit the space in exponents, subscripts, or superscripts.

Examples: $\int_{a}^{x+2}$ a_{n-1} $a_1 x^{n+1}$

Exception 2: Omit the space between a $+$, $-$, $\pm$, or $\mp$ sign which indicates a positive or negative number or expression.

Examples: $+3$ -4 $-x$ $\pm 2\sqrt{3}$ $\pm(a - 2b)$

$-1/x$, but $-\frac{1}{x} \pm \frac{3}{y}$

Before and after $=$, $\neq$, $\equiv$, $\not\equiv$, $\sim$, $\cong$, $\rangle$, $\langle$, $\geqq$, $\leqq$, $\perp$, $\parallel$, and $\rightarrow$ (except as subscripts).

Examples: $y \equiv 5$ $6 \times 5 = 30$ $x < -y^2$ $\triangle ABC = \triangle PQR$ $x \neq 0$

$AB \perp BC$ $-1 < x \leqq 2$ $a \rightarrow b$, but $\lim_{x \to 0} y^2 \sum_{i=1}^{n} x^i$

Before and after symbols such as lim, ln, sin, cos, tan, log, mod, $\sin^{-1}$, arc sin, tanh, $\cosh^{-1}$.

Examples: $3 \cos 2x \quad \log_{10} x \quad 2 \sin x \quad A \equiv B, \bmod M$

$$\sin A \cos B + \cos A \sin B \qquad e^{ax} \sin bx \qquad \sin^{-1} x$$

$$\tan^{-1} (\tan x) \quad \text{or} \quad \tan^{-1} \tan x \qquad \lim_{x \to 1} (x + 7)$$

$$\sin (x + y) \quad \sin^2 45^\circ \quad \log \log 3 \quad \log \cos x \quad \arcsin \tfrac{1}{2}$$

NOTE: Some authorities would omit the space in the last five examples, writing

$\sin(x + y) \quad \sin^2 45^\circ \quad \log\log 3 \quad \log\cos x \quad \arcsin \frac{1}{2}$

These authorities would also write $2\sin x$. Either is good form, but be consistent.

Between terms of a sequence or between each of a number of displayed expressions.

Examples: $a, a + b, a + 2b, \cdots,$

$$x, x^2, x^3, x^4, \cdots,$$

$$\text{Evaluate for } x = 5\text{: } x^2, \ 3x^4, \ x - 1, \ \frac{x - 1}{5}$$

To separate the symbol $\cdots$ meaning "and so forth" or "and so forth up to."

Examples: $2 + 4 + 6 + \cdots + 2n$

$$1, 3, 5, \cdots, 2n - 1, \cdots,$$

$$x, y, \cdots, w \text{ but not } x, y, \cdots w$$

NOTE: This symbol consists of exactly three dots, neither more nor less, centrally placed. In a series, the algebraic signs appear both before and after the symbol of omission. If the symbol appears at the end of a sentence, the fourth dot is placed as a period; commas may be used for punctuation.

Example: The sequences $a, a^2, a^3, \cdots,$
$b, b^2, b^3, \cdots,$
and $c, c^2, c^3, \cdots,$
are like $d, d^2, d^3, \cdots.$

Between the dots in a line of dots used to indicate "and so forth" or "and so forth up to" in a set of displayed equations. (The dots are in the center of the line of writing.)

Examples:

$$A = BQ + R_1$$
$$B = R_1Q_1 + R_2$$
$$\cdots\cdots\cdots$$
$$R_{i-1} = R_iQ_i + c$$

If $\qquad f(x) = (x - s)^m(x - r_1)(x - r_2) \cdots,$

$$\begin{aligned} f'(x) = {} & m(x-s)^{m-1}(x-r_1)(x-r_2)\cdots \\ & + (x-s)^m(x-r_2)(x-r_3)\cdots \\ & + (x-s)^m(x-r_1)(x-r_3)\cdots \\ & + \cdots\cdots\cdots\cdots \end{aligned}$$

Between the vertical bar and the elements of a determinant, likewise one space between elements which appear in the same row. (If an element itself consists of more than one term, two spaces may be used for separation.) Except for numbers in our decimal system, elements in a column are, as nearly as possible, centered about a vertical line.

Examples: $\begin{vmatrix} -2 & x & 2 \\ 11 & -1 & 3 \\ 3 & y & 4 \end{vmatrix}$ $\begin{vmatrix} 1234 & x-y+z & y \\ 3 & a & a+2b \\ 55 & z+a & 2x \end{vmatrix}$

After the integral sign and before dx in integral symbols.

Examples: $\int z^2\,dz$ $\int \sin mx \cos nx\,dx$ $\int_a^b \sin x\,dx$

$$\iint z^2 r\,d\theta\,dr \qquad \int_a^b \int_c^d (x-2y)\,dy\,dx$$

After the summation symbol.

Examples: $\sum x^2$ $\sum_{k=1}^{n} k^3$

Before and after the symbols dy, dx, etc.

Examples: $y\,dx + x\,dy$ $3\,dy + x^2\,df(x) = 7$ $\tan A = \dfrac{r\,d\theta}{dr}$

Use two spaces:

Before and after a formula or expression which appears in a line of text. (If the expression cannot be completed in a single line of text it should appear in displayed form.)

Example: The expression e^x represents a transcendental number.

Use at least two spaces:

Between a formula or equation and some explanation or qualification.

Examples: $a^0 = 1 \qquad (a \neq 0)$

$$\int_a^x u^{-1}\,du = \ln x - \ln a \quad (a > 0)$$

or $$\int_a^x u^{-1}\,du = \ln x - \ln a,\ a > 0$$

Use at least three spaces:

Between two separate statements displayed in the same line; if more than two statements appear, the spaces between them should be equal.

Examples: $a^2 + 2b = 7, \qquad 2c > 0.$
$a = 3, \qquad b = 4, \qquad c = 5.$

Lining up displayed material: When fractions appear in a line of writing, the main bar of the fraction should be in line with the minus sign, the horizontal bar of the plus sign, and the center of the equality sign. A comma or period is placed in line with the main bar of the final fraction.

Example: $$3x - 7 + \frac{a^2}{b} = \frac{p+y}{m} + \frac{\dfrac{3mn^2}{2y}}{\dfrac{a}{x}} + \tan\frac{x}{3}.$$

Displayed material is centered on the width of the page, if several equations appear in sequence unbroken by text the equality signs are placed in vertical alignment.

Examples:

$$3x + 2y - (x^2 + y^2) = a + b - c^2$$
$$r + s = 3mn - 17pqrt$$
$$p + q - t = |3|$$

Likewise
$$4x - 3y = 15$$
$$x + y = 1$$

although this may result in uneven spacing for one or more equations. Some authorities would align the left terms of such equations, i.e.,

$$4x - 3y = 15$$
$$x + y = 1.$$

In any event, be consistent.

If an equation or expression requires more than one line, try to make the break at some major division; if more than one equality sign is involved, the break should occur at such a sign. Avoid if at all possible breaking material within parentheses.

Examples:

$$(x + y + z)^2 - 3(xz + yz) = x^2 + y^2 + z^2 + 2xy + 2xz + 2yz - 3xz - 3yz = x^2 + y^2 + z^2 + 2yz - xz - yz$$

$$A(x' \cos \theta - y' \sin \theta)^2 + B(x' \cos \theta - y' \sin \theta)(x' \sin \theta + y' \cos \theta) + C(x' \sin \theta + y' \cos \theta)^2$$

but *not*

$$A(x' \cos \theta - y' \sin \theta)^2 + B(x' \cos \theta - y' \sin \theta)(x' \sin \theta + y' \cos \theta) + C(x' \sin \theta + y' \cos \theta)^2$$

---

50 YEARS OF SCIENCE TEACHING IN NEW JERSEY

All during this year the science teachers in the state of New Jersey are celebrating their fiftieth anniversary year in the teaching of science in the high schools with the New Jersey Science Teachers Association in the lead position. At one of their first meetings, held at Princeton University, Woodrow Wilson, then President of Princeton, welcomed the members of the Association to Princeton.

The history of the New Jersey Science Teachers Association parallels the history of science teaching in New Jersey. Its programs and activities reflect the changes in science teaching during this half century. Its growth also parallels the development of teacher organizations in New Jersey, being—as far as research indicates—the first subject area organization of its kind in the State, as well as one of the first in the country.

DOCUMENTATION CONFERENCE

Western Reserve University will be host at a three-day conference on "Practical Utilization of Recorded Knowledge—Present and Future," to be held Jan. 16–18, 1956, on the WRU campus in Cleveland, Ohio.

Emphasis will be on organization and use of printed material in such areas as the sciences, law, patents, military and government information, business, industry and education.

Offering the conference will be Western Reserve's School of Library Science and its new Center for Documentation and Communication Research. Dr. Jesse H. Shera is dean of the library school; director and associate director, respectively, of the Center are James W. Perry and Allen Kent. The conference will follow the Jan. 15 dedication of WRU's new $1,600,000 library.

More than 30 experts will be on the three-day program.

Complete information on the conference is available from the Dean, School of Library Science, Western Reserve University, Cleveland 6, Ohio.

CARNEGIE TECH OVERFLOW

Demand for higher education in the United States continues to expand at an increasing rate while the expansion of educational facilities is still creeping along. Applications for admission to Carnegie Institute of Technology in Pittsburgh this fall were the largest since the general dip following the rush to college in the immediate post-war period. For the second consecutive year the number of applicants was 25 per cent above 1953.

New Carnegie Tech applicants from all corners of the world numbered almost 3500 this year. But only one-quarter of these new prospective students can be admitted. "Our capacity is fixed," explained Carnegie Admissions Chairman, Dr. John M. Daniels. "With present facilities we can adequately handle no more than 900 new students each year."

PROPOSED AMENDMENTS TO THE BY-LAWS OF THE CENTRAL ASSOCIATION OF SCIENCE AND MATHEMATICS TEACHERS

The following proposed amendments to the By-Laws of the Central Association of Science and Mathematics Teachers will be brought before the membership for vote at its annual business meeting to be held in Detroit, Michigan, November, 1955. To assist the members in studying the proposed revisions, each section of the By-Laws under consideration is printed in full in the left column as it *will* read if the proposed amendment, appearing in italics, is voted. The *present* wording of the portion of the section to be amended appears in a parallel position at the right.

PROPOSED AMENDMENTS	*PRESENT WORDING*
PROPOSED ARTICLE I—SECTION III. *TERMINATION OF MEMBERSHIP:* The membership of any member of the Association shall be automatically terminated for any delinquency of dues, or other charges owing to the Association, continued for a period of six months. *Any member of the Association may be expelled for any reason deemed sufficient by the Board of Directors by a two-thirds affirmative vote of all those present at any meeting of the Board of Directors, or by a two-thirds affirmative vote of all the members present at any meeting of the Association.* But no vote of expulsion may be taken unless written notice shall have been given not less than thirty days prior to the date for said meeting to the member proposed to be expelled, which said notice shall advise said member of the time and place of said meeting and the reasons for which expulsion is proposed. Like notice shall be given to all other members of the Association. It shall be the privilege of the member proposed to be expelled to appear and be heard by the members at the meeting at which a vote is to be taken on the question of expulsion.	Any member of the Association may be expelled for any reason deemed sufficient by the Board of Directors by a two-thirds affirmative vote of all those present at any meeting of the Directors or the members of the Association.
PROPOSED ARTICLE II—SECTION I. *TIME OF MEETING: (a) ANNUAL MEETINGS:* *The annual business meeting shall be held on the second day of the annual convention as set by the Board of Directors.*	The annual meetings shall be held on the second day after the last Thursday in November of each year.
PROPOSED ARTICLE III—SECTION I. *OFFICERS:* The officers of this Association shall be a	

President, a Vice-President, a Secretary, a Treasurer and Business Manager, an Editor of the Journal, and an Historian. *One or more Assistant Secretaries, Assistant Editors, and Assistant Treasurers may be appointed by the Board of Directors.*

One or more Assistant Secretaries and Assistant Treasurers may be appointed by the President.

PROPOSED ARTICLE III—SECTION III.

ELECTION, TENURE OF OFFICE, COMPENSATION:

The President and Vice-President shall be elected by the members of the Association at the annual meeting and shall serve for a term of one year or until their *successors* are elected. *The Treasurer and Business Manager, Editor of the Journal, and Secretary-Historian shall be appointed for a term of three years by the Board of Directors at a meeting to be held following the annual meeting of the Association, or at the Spring meeting of the Board of Directors. The Secretary-Historian shall take office immediately following appointment. The Treasurer and Business Manager, and Editor of the Journal shall take office at the beginning of the fiscal year following their appointment. They may be reappointed.* The compensation of the officers, if any, shall be fixed by the Board of Directors.

The Treasurer and Business Manager, Editor of the Journal, Historian, and Secretary shall be appointed by the Board of Directors at a meeting to be held following the annual meeting of the Association, and shall serve for a term of three years. Their terms may be renewable.

PROPOSED ARTICLE III—SECTION IV.

(d) TREASURER AND BUSINESS MANAGER:

The Treasurer and Business Manager shall collect all dues and hold all moneys and keep a record of all receipts and disbursements. He shall give a report at the annual meeting of the Association. He shall pay out funds on the order of the Board of Directors and the Executive Committee.

(Amend to delete the final sentence appearing at the right.)

He shall also act as Business Manager of the Journal.

FACTS ABOUT WESTINGHOUSE AND ATOMIC ENERGY

As a pioneer in the field of atomic energy, Westinghouse has achieved the following "firsts" in its atomic projects:

1—First industry-built atom smasher.
2—First quantity production of metallic uranium.
3—First large-scale production of pure zirconium for atomic reactor.
4—First two atomic engines to produce power in substantial quantities.
5—First nuclear power plant for a large surface vessel—(under development).
6—First full-scale reactor plant for an electric generating station—(under construction).
7—First privately-financed atomic equipment plant.
8—First industry-owned nuclear materials testing reactor—(being designed).

PROBLEM DEPARTMENT

CONDUCTED BY MARGARET F. WILLERDING

Harris Teachers College, St. Louis, Mo.

This department aims to provide problems of varying degrees of difficulty which will interest anyone engaged in the study of mathematics.

All readers are invited to propose problems and to solve problems here proposed. Drawings to illustrate the problems should be well done in India ink. Problems and solutions will be credited to their authors. Each solution, or proposed problem, sent to the Editor should have the author's name introducing the problem or solution *as on the following pages.*

The editor of the department desires to serve its readers by making it interesting and helpful to them. Address suggestions and problems to Margaret F. Willerding, Harris Teachers College, St. Louis, Missouri.

SOLUTIONS AND PROBLEMS

Note. Persons sending in solutions and submitting problems for solution should observe the following instructions.

1. Solutions should be in double spaced typed form.

2. Drawings in India ink should be on a separate page from the solution.

3. Give the solution to the problem which you propose if you have one and also the source and any known reference to it.

4. Each solution or problem for solution should be on a separate page.

In general, when several solutions are correct, the ones submitted in the best form will be used.

LATE SOLUTIONS

2438, 2442, 2443, 2444, 2446, 2448. *O. S. Narayanaswamy, Madras, South India.*

2450, 2451, 2452. *Charles R. Berndtson, Venalhaven, Maine.*

2445, 2446, 2450, 2452, 2454. *C. W. Trigg, Los Angeles, Calif.*

2431. *J. M. Synnerdahl, Erie, Pa.*

2453. *Proposed by C. W. Trigg, Los Angeles City College.*

(a) Show that every even integer greater than $12M+22$ can be expressed as the sum of M abundant numbers.

(b) Find the smallest integers which can be expressed as the sum of two abundant numbers in 1, 2, 3, 4, 5, 6, 7, 8, 9 ways.

Solution by the Proposer

Multiples of perfect numbers or of abundant numbers are abundant.

(a) The only abundant numbers less than 56 are $6n$, 20 and 40. Hence, if $n>1$, all numbers of the form $6n+12$, $6n+20$, and $6n+40$ can be expressed as the sum of two abundant numbers. That is, every number $6k \geq 24$, $6k+2 \geq 32$, and $6k+4 \geq 52$ is the sum of two abundant numbers. These comprise all even numbers >46 or $12 \cdot 2+22$. Since the smallest abundant number is 12, it follows that every even number greater than $12 \cdot 3+22$ can be expressed as the sum of 3 abundant numbers. In general, then, every even number greater than $12M+22$ can be expressed as the sum of M abundant numbers.

(b) The twenty-one abundant numbers less than 100 are 12, 18, 20, 24, 30, 36, 40, 42, 48, 54, 56, 60, 66, 70, 72, 78, 80, 84, 88, 90, 96. By considering the sums of these in pairs, we have that

$24=12+12,$

$36=12+24=18+18,$

$48=12+36=18+30=24+24,$

$66=12+54=18+48=24+42=30+36,$

$60=12+48=18+42=20+40=24+36=30+30,$

$84=12+72=18+66=24+60=30+54=36+48=42+42,$

$90=12+78=18+72=20+70=24+66=30+60=36+54=42+48,$

$96=12+84=18+78=24+72=30+66=36+60=40+56=42+54=48+48,$

$108=12+96=18+90=20+88=24+84=30+78=36+72=42+66=48+60=54+54,$

are the smallest integers which can be expressed as the sum of two abundant numbers in 1, 2, 3, 4, 5, 6, 7, 8, 9 ways. This constitutes a correction of the foot-note to E 903, *American Mathematical Monthly*, **57**, 562, October 1950.

Proceeding in like manner we have that

$36=12+12+12,$

$48=12+12+24=12+18+18,$

$54=12+12+30=12+18+24=18+18+18,$

$60=12+12+36=12+18+30=12+24+24=18+18+24=20+20+20,$

$80=12+12+56=12+20+48=18+20+42=20+20+40=20+24+36=20+30+30,$

are the smallest integers which can be expressed as the sum of three abundant numbers in 1, 2, 3, 5, 6 ways. 72 can be expressed in 8 ways, 78 in 9, 84, in 11 90 in 12, 96 in 16, 102 in 18, and 108 in 20 ways.

2455. *Proposed by Brother Felix John, Philadelphia, Pennsylvania.*

In the triangle ABC, h_c, t_c and m_c meet side c in points D, E and F respectively. Derive a formula for segment EF.

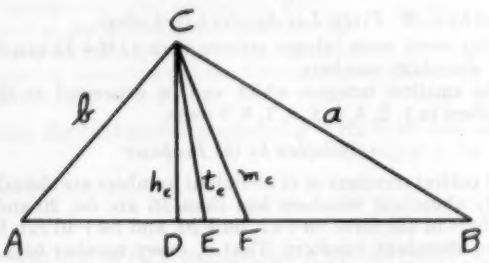
Solution by C. W. Trigg, Los Angeles City College

METHOD I.

$$DF=\sqrt{m^2-h^2} \quad \text{and} \quad DE=\sqrt{t^2-h^2},$$

hence

$$EF=\sqrt{m^2-h^2}-\sqrt{t^2-h^2}.$$



METHOD II.

Assume

$$a \geqq b.$$

$$AF=c/2 \quad \text{and} \quad AE=bc/(a+b),$$

so

$$EF=AF-AE=c/2-bc/(a+b)=c(a-b)/2(a+b).$$

Solutions were also presented by Richard H. Bates, Milford, N. Y.; Clinton E. Jones, Nashville, Tenn.; Henry Mattison, Cambridge, Mass.; Walter Warne, St. Petersburg, Fla.; and the proposer.

2456. *Proposed by A. R. Haynes, Tacoma, Washington.*

Show

$$\frac{(4+\sqrt{15})^{3/2}+(4-\sqrt{15})^{3/2}}{(6+\sqrt{35})^{3/2}-(6-\sqrt{35})^{3/2}}=\frac{7}{13}.$$

Solution by C. W. Trigg, Los Angeles City College

$$(8\pm 2\sqrt{15})^{1/2}=\sqrt{5}\pm\sqrt{3} \quad \text{and} \quad (12\pm 2\sqrt{35})^{1/2}=\sqrt{7}\pm\sqrt{5}.$$

Hence when numerator and denominator of the left hand member of the equation are multiplied by $(2)^{3/2}$ we have

$$\frac{(\sqrt{5}+\sqrt{3})^3+(\sqrt{5}-\sqrt{3})^3}{(\sqrt{7}+\sqrt{5})^3-(\sqrt{7}-\sqrt{5})^3}=\frac{2(5\sqrt{5}+9\sqrt{5})}{2(21\sqrt{5}+5\sqrt{5})}=\frac{7}{13}.$$

As originally printed, with a positive sign in the denominator, the fraction reduces to

$$\frac{(5\sqrt{5}+9\sqrt{5})}{2(7\sqrt{7}+15\sqrt{7})}=\frac{7(\sqrt{5})}{11\sqrt{7}}.$$

Solutions were also presented by J. Byers King, Denton, Md.; Willis B. Porter, New Iberia, La.; Harry D. Rudermann, Bronx, N.Y.; George Senge, Los Angeles, Calif.; Richard R. Williams, Jr., Marshall, Tex.; and the proposer.

2457. *Proposed by Gerald Freilich, Brooklyn, N.Y.*

Problem:

On the top surface of a block of wood h inches high, a wedge is cut whose plane angle is β, and whose edge makes an angle α with the horizontal. A ball of radius r rests in the upper part of the wedge such that its center lies in the plane of the top surface of the block and such that the ball is tangent to the plane of the side of the block. If the distance between the point which is the intersection of the higher level of the edge of the dihedral angle with the side of the block, and the bottom of the block is represented by d, express d in terms of α, β, h, and r.

Solution by the Proposer

Let s be the distance from the center of the ball to the edge of the dihedral angle. From figure 1, it can be seen that

$$s=r\csc\frac{\beta}{2}.$$

Let x be the depth of the higher level of the wedge so that

$$x+d=h.$$

(See figure 2)

From figure 3, since the two right triangles are similar,

$$\frac{x}{x\csc\alpha}=\frac{s}{r+x\cot\alpha}$$

$$\therefore \quad r+x\cot\alpha=s\csc\alpha$$

$$\therefore \quad x\cot\alpha=s\csc\alpha-r$$

$$\therefore \quad x=\frac{s\csc\alpha}{\cot\alpha}-\frac{r}{\cot\alpha}$$

$$=\frac{s-r\sin\alpha}{\cos\alpha}$$

$$= \frac{r \csc \frac{\beta}{2} - r \sin \alpha}{\cos \alpha}$$

$$= \frac{r}{\cos \alpha}\left(\csc \frac{\beta}{2} - \sin \alpha\right)$$

$$d = h - x$$

$$= h - \frac{r}{\cos \alpha}\left(\csc \frac{\beta}{2} - \sin \alpha\right)$$

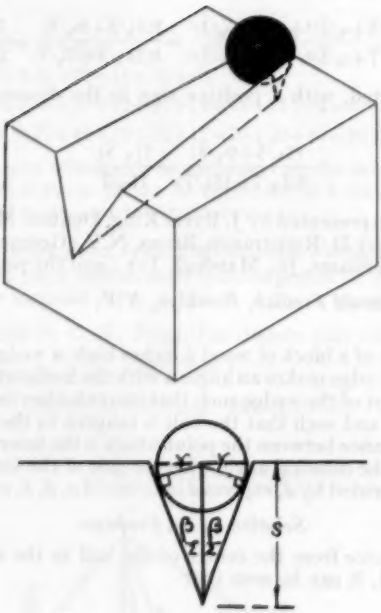


FIG. 1

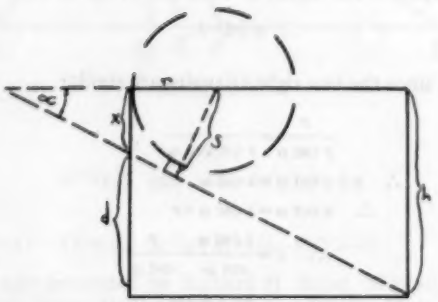


FIG. 2

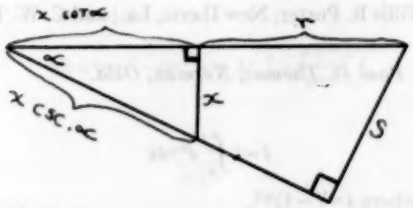


FIG. 3

2458. *Proposed by Julius S. Miller, New Orleans, Louisiana.*

A car, starting from rest, has a constant acceleration a and acquires a velocity V, which it then maintains for an interval; it then slows down to a stop at a constant rate b. If D is the total distance covered, show the total time to be

$$\frac{D}{V}+\frac{V}{2}\left(\frac{1}{a}+\frac{1}{b}\right).$$

Solution by the Proposer

The usual equations for uniformly accelerated motion apply. Consider the total distance as made up of parts s_1, s_2, s_3 and the corresponding times t_1, t_2, t_3. Then

$$s_1=\frac{V^2}{2a} \quad \text{and} \quad t_1=\frac{V}{a}.$$

Also

$$s_2=V\cdot t_2 \quad \text{and} \quad t_2=\frac{s_2}{V}$$

similarly

$$s_3=\frac{V^2}{2b} \quad \text{and} \quad t_3=\frac{V}{b}.$$

Now, T, the total time is

$$t_1+t_2+t_3=\frac{V}{a}+\frac{s_2}{V}+\frac{V}{b}. \tag{1}$$

Also, $s_1+s_2+s_3=D$, whence

$$s_2=D-s_1-s_3$$

$$s_2=D-\frac{V^2}{2a}-\frac{V^2}{2b}$$

$$s_2=D-\frac{V^2}{2}\left(\frac{1}{a}+\frac{1}{b}\right).$$

Putting this value of s_2 in (1) gives

$$T=V\left(\frac{1}{a}+\frac{1}{b}\right)+\frac{D}{V}-\frac{V}{2}\left(\frac{1}{a}+\frac{1}{b}\right)$$

$$=\frac{D}{V}+\frac{V}{2}\left(\frac{1}{a}+\frac{1}{b}\right)$$

which was to be shown.

Solutions were also offered by Richard H. Bates, Milford, N.Y.; A. R. Haynes,

Tacoma, Wash.; Willis B. Porter, New Iberia, La.; and C. W. Trigg, Los Angeles, Calif.

2459. *Proposed by Paul D. Thomas, Norman, Okla.*

Show that

$$I = i\int_0^i e^{\pi i x}dx$$

is a real number, where $i=(-1)^{1/2}$.

Solution by C. W. Trigg, Los Angeles City College

$$I = i\int_0^i e^{\pi i x}dx = \frac{1}{\pi}\int_0^i e^{\pi i x}(\pi i dx)$$

$$= \frac{1}{\pi}\left[e^{\pi i x}\right]_0^i = \frac{1}{\pi}(e^{-\pi}-1) \quad \text{or} \quad (1-e^{\pi})/\pi e^{\pi}.$$

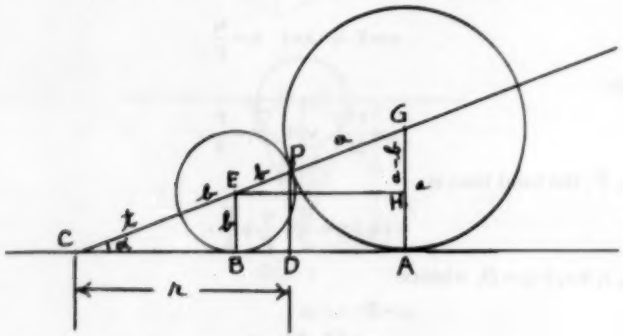
A solution was also offered by the proposer.

2460. *Proposed by Martin Hirsch, Brooklyn, New York.*

Two spheres with radii a and b, $a>b$, are glued together at a point P. The solid so formed is placed on a horizontal table and is made to roll, without slipping, on the table; prove that P describes a circle of radius r given by $r^2(a^2-b^2)=16a^2b^2$.

(NOTE: this formula, given here just as it was printed in the March issue of SCHOOL SCIENCE AND MATHEMATICS, is erroneous, clearly through a printer's error. The correct formula is developed below.)

Solution by Charles H. Butler, Kalamazoo, Michigan



From similar triangles CBE and CAG we get

$$\frac{t+b}{t+2b+a}=\frac{b}{a}$$

whence

$$t=\frac{2b^2}{a-b}.$$

From triangle EHG we get

$$\sin\alpha=\frac{a-b}{a+b}$$

whence

$$\cos\alpha=\sqrt{1-\sin^2\alpha}=\sqrt{1-\left(\frac{a-b}{a+b}\right)^2}$$

which reduces to

$$\frac{2\sqrt{ab}}{a+b}.$$

From triangle CDP we get

$$\cos\alpha=\frac{r}{t+2b}.$$

Therefore

$$\frac{r}{t+2b}=\frac{2\sqrt{ab}}{a+b},$$

which upon substituting the above value of t, solving for r, and simplifying, gives

$$r=\frac{4ab\sqrt{ab}}{a^2-b^2},$$

whence $r^2(a^2-b^2)^2=16a^3b^3$.

Solutions were also offered by Richard H. Bates, Milford, N.Y.; Harry D. Ruderman, Bronx, N.Y.; George Senge, Los Angeles, Calif.; Warren Rufus Smith, Passe a Grille Beach, Fla.; C. W. Trigg, Los Angeles, Calif.; and the proposer.

STUDENT HONOR ROLL

The Editor will be very happy to make special mention of classes, clubs, or individual students who offer solutions to problems submitted in this department. Teachers are urged to report to the Editor such solutions.

Editor's Note: For a time each student contributor will receive a copy of the magazine in which his name appears.

PROBLEMS FOR SOLUTION

2479. *Proposed by W. R. Utz, Columbia, Mo.*

Given a quantity of liquid containing a_1 and b_1 per cents of two chemicals and another quantity of liquid containing, respectively, a_2 and b_2 per cents of the same chemicals contained in the first liquid. Show that a liquid can be had by mixing appropriate quantities of the two given liquids to secure, respectively, x and y per cents of these chemicals when, and only when, (x, y) is a point in the x, y-plane on the segment joining the points (a_1, b_1) and (a_2, b_2).

2480. *Proposed by Brother Felix John, Philadelphia, Pa.*

Derive a formula for the sum of all the permutations of the n numbers 1, 2, 3, $\cdots$, n, taken all at a time.

2481. *Proposed by Laverne Clark, Sac City, Iowa.*

The Hammond Organ has nine drawbars. Each drawbar may be drawn out to eight degrees of expression. How many combinations are possible using all drawbars to the various degrees of expression?

2482. *Proposed by Edward C. Varnum, Clyde, Ohio.*

Two opposing armies containing a and b men respectively fire one round in a given unit of time. The ratio of the number of men killed to the number of shots fired is r. The army of b men is destroyed in n units of time. Express n in terms

of a, b, and r and also express the number remaining alive in the first army.

2483. *Proposed by Norman Anning, Alhambra, Calif.*

Give a method for finding all kinds of parallelograms having integral sides and integral diagonals. Such things exist. For example here are two kinds:

Sides	*Diagonals*
8, 9	11, 13
11, 13	16, 18
16, 18	22, 26

2484. *Proposed by Brother Felix John, Philadelphia, Pa.*

If in triangle ABC, the circumradius, R, equals t_c, the bisector of the angle C, and angle A equals angle B, find the number of degrees in angle C.

BOOKS AND PAMPHLETS RECEIVED

GENERAL PHYSICS, Second Edition, by Oswald Blackwood, Ph.D., *Late Professor of Physics, The University of Pittsburgh*, and William Kelly, Ph.D., *Associate Professor of Physics, The University of Pittsburgh*. Cloth. Pages x+704. 14.5×23 cm. 1955. John Wiley and Sons, Inc., 440 Fourth Avenue, New York 16, N. Y. Price $6.75.

ANALYTIC GEOMETRY, Second Edition, by Ross R. Middlemiss, *Professor of Mathematics, Washington University*. Cloth. Pages ix+310. 15×23 cm. 1955. McGraw-Hill Book Company, Inc., 330 West 42nd Street, New York 36, N. Y. Price $3.75.

GENERAL PRINCIPLES OF GEOLOGY, by J. F. Kirkaldy, D.Sc., F.G.S., *Reader in Geology, University of London*. Cloth. 327 pages. 15×23 cm. 1955. Philosophical Library, Inc., 15 East 40th Street, New York 16, N. Y. Price $6.00.

INTRODUCTION TO COLLEGE MATHEMATICS, Revised Edition, by M. A. Hill, Jr., and J. Burton Linker, *University of North Carolina*. Cloth. Pages xiv+428+101. 14×21 cm. 1955. Henry Holt and Company, 383 Madison Avenue, New York 17, N. Y. Price $5.25.

UNIFIED ALGEBRA AND TRIGONOMETRY, by Elbridge P. Vance, *Oberlin College*. Cloth. Pages ix+354. 14.5×21.5 cm. 1955. Addison-Wesley Publishing Company, Inc., Cambridge 42, Mass. Price $4.50.

NEW WORLD OF CHEMISTRY, by Bernard Jaffe, *Department of Physical Science, James Madison High School, New York City*. Cloth. Pages ix+678. 15×22.5 cm. 1955. Silver Burdett Company, 45 East 17th Street, New York 3, N. Y. Price $4.16.

PRINCIPLES OF THE IN-FINITE PHILOSOPHY, by Jefferson C. Barnhart. Cloth. 68 pages. 13×20.5 cm. 1955. Philosophical Library, Inc., 15 East 40th Street, New York 16, N. Y. Price $2.75.

ELEMENTS OF PHYSICS, SECOND EDITION, by George Shortley, B.E.E., Ph.D., Operations Research Office, The Johns Hopkins University, *Formerly Professor of Physics, The Ohio State University;* and Dudley Williams, A.B., Ph.D., *Professor of Physics, The Ohio State University*. Cloth. Pages xiv+880+xviii. 14.5×23 cm. 1955. Prentice-Hall, Inc., 70 Fifth Avenue, New York 11, N. Y.

MATHEMATICS FOR HIGHER NATIONAL CERTIFICATE, Volume 1, by S. W. Bell, B.Sc., and H. Matley, B.Sc., *Lecturers in Mathematics at Norwich City College, Norwich, England*. Cloth. Pages xii+293. 13.5×21.5 cm. 1955. Cambridge University Press, 32 East 57th Street, New York 22, N. Y. Price $2.75.

COLLEGE ALGEBRA AND PLANE TRIGONOMETRY, by Abraham Spitzbart and Ross H. Bardell, *University of Wisconsin*. Cloth. Pages xiii+408. 14×21.5 cm. 1955. Addison-Wesley Publishing Company, Inc., Cambridge 42, Mass. Price $4.50.

OUR WONDERFUL EYES, by John Perry. Cloth. 158 pages. 13.5×20.5 cm. 1955. Whittlesey House, McGraw-Hill Book Company, Inc., 330 West 42nd Street, New York 36, N. Y. Price $2.75.

FUNDAMENTAL FORMULAS OF PHYSICS, edited by Donald H. Menzel, *Harvard University*. Cloth. Pages xxxv+765. 14×21.5 cm. 1955. Prentice-Hall, Inc., 70 Fifth Avenue, New York 11, N. Y.

ANALYTIC GEOMETRY, by Neal H. McCoy and Richard E. Johnson, *Department of Mathematics, Smith College, Northampton, Massachusetts*. Cloth. Pages xiv +301. 15×23 cm. 1955. Rinehart and Company, Inc., 232 Madison Avenue, New York 16, N. Y. Price $4.00.

YOUR CAREER IN PHYSICS, by Philip Pollack, Cloth. 127 pages. 13×20 cm. 1955. E. P. Dutton and Company, Inc., 300 Fourth Avenue, New York 10, N. Y. Price $2.75.

HIGHER ARITHMETIC, by Virgil S. Mallory, *Professor of Mathematics, State Teachers College, Montclair, New Jersey*, and Kenneth C. Skeen, *Instructor of Mathematics, Contra Costa Junior College, Richmond, California*. Cloth. Pages v+418. 12.5×20.5 cm. 1955. Benj. H. Sanborn and Company, 5559 Northwest Highway, Chicago 30, Ill. Price $3.20.

INTRODUCTION TO PHYSICS, by Frank M. Durbin, *Professor of Physics, Oklahoma Agricultural and Mechanical College*. Cloth. Pages xiv+780. 15×23 cm. 1955. Prentice-Hall, Inc., 70 Fifth Avenue, New York 11, N. Y.

THE GIFTED STUDENT AS FUTURE SCIENTIST, by Paul F. Brandwein, *Chairman, Science Department, Forest Hills High School, New York, N. Y.* Cloth. Pages xvi+107. 12.5×20.5 cm. 1955. Harcourt, Brace and Company, Inc., 383 Madison Avenue, New York 17, N. Y.

SECURITY FOR ALL AND FREE ENTERPRISE. A SUMMARY OF THE SOCIAL PHILOSOPHY OF JOSEF POPPER-LYNKEUS, edited by Henry I. Wachtel. Cloth. Pages xi+162. 13×21.5 cm. 1955. Philosophical Library, Inc., 15 East 40th Street, New York 16, N. Y. Price $3.00.

STATISTICAL METHODS, by Frederick C. Mills, *Columbia University*. Cloth. Pages xviii+842. 15×23.5 cm. 1955. Henry Holt and Company, 383 Madison Avenue, New York 17, N. Y. Price $6.90.

MATHEMATICS AND MEASUREMENTS, By Merrill Rassweiler, *Associate Professor of Physical Science and Mathematics, The General College, University of Minnesota*, and J. Merle Harris, *Assistant Professor of Natural Sciences, The General College, University of Minnesota*. Cloth. Pages ix+351. 15×23 cm. 1955. Row, Peterson and Company, 1911 Ridge Avenue, Evanston, Illinois. Price $4.50.

THIS WORLD OF OURS, by Abram Glaser, *College of the City of New York*. Cloth. Pages xiii+492. 13×20.5 cm. 1955. Philosophical Library, Inc., 15 East 40th Street, New York 16, N. Y. Price $5.00.

PRINCIPLES OF MATHEMATICS, by C. B. Allendoerfer, *Professor and Executive Officer, Department of Mathematics, University of Washington*, and C. O. Oakley, *Professor and Department Head, Department of Mathematics, Haverford College*. Cloth. Pages xv+448. 15×23 cm. 1955. McGraw-Hill Book Company, Inc., 330 West 42nd Street, New York 36, N. Y. Price $5.00.

AN INTRODUCTION TO THE ELECTRONIC THEORY OF VALENCY, by J. C. Speakman, M.Sc., Ph.D., D.Sc. *Senior Lecturer in Chemistry in the University of Glasgow.* Cloth. Pages vii+180. 12×18.5 cm. 1955. St. Martin's Press, Inc., 103 Park Avenue, New York 17, N. Y. Price $2.50.

ANCIENT EDUCATION, by William A. Smith, *University of California.* Cloth. Pages xii+309. 13.5 ×20.5 cm. 1955. Philosophical Library, 15 East 40th Street, New York 16, N. Y. Price $3.75.

ARITHMETIC WE NEED, Grades 3, 4, 5, 6, and 7, by Guy T. Buswell, *University of California, Berkeley;* William A. Brownell, *University of California, Berkeley;* and Irene Sauble, *Detroit Public Schools, Detroit, Michigan.* Cloth. 15×22 cm. Grade 3, 148 pages. Grade 4, 136 pages. Grade 5, 136 pages. Grade 6, 136 pages. Grade 7, 136 pages. 1955. Ginn and Company, Statler Building, Boston 17, Mass. Price each $2.08.

MATHEMATICS FOR ENGINEERS, Part I, Ninth Edition, by W. N. Rose, B.Sc., *Late Head of Mathematics Department at the Borough Polytechnic Institute, London, England.* Cloth. Pages xiv+527. 13.5×21.5 cm. 1955. Chapman and Hall, Ltd., 37 Essex Street, London, W.C.2. Price 21s. net.

THE REAL PROJECTIVE PLANE, Second Edition, by H. S. M. Coxeter, *Professor of Mathematics, University of Toronto.* Cloth. Pages xi+226. 13.5×21.5 cm. 1955. Cambridge University Press, 32 East 57th Street, New York 22, N. Y. Price $4.75.

BASIC VACUUM TUBES AND THEIR USES, by John F. Rider and Henry Jacobowitz. Cloth. Pages iv+204. 13.5×21.5 cm. 1955. John F. Rider, Publisher, Inc. 480 Canal Street, New York 13, N. Y. Price $4.50.

THE HANDBOOK OF PRIVATE SCHOOLS, Thirty-Sixth Edition, by Porter Sargent. Cloth. 1264 pages. 12×18 cm. 1955. Porter Sargent, 11 Beacon Street, Boston 8, Mass. Price $8.00.

USING CHEMISTRY, by Oscar E. Lanford, *Dean of the College at the New York State College for Teachers.* Cloth. Pages xiii+722. 14.5×23 cm. 1955. McGraw-Hill Book Company, Inc., 330 West 42nd Street, New York 36, N. Y. Price $4.56.

MICROBIOLOGY, by Ernest A. Gray, M.Sc., M.R.C.V.S., *Chief Bacteriologist, Bayer's Biological Institute, Exning.* Cloth. Pages xii+175. 12×18 cm. 1955. Philosophical Library, Inc., 15 East 40th Street, New York 16, N. Y. Price $3.75.

DICTIONARY OF MECHANICAL ENGINEERING TERMS, originally compiled by J. G. Horner, A.M.I.M.E. Seventh Edition Revised and Enlarged by Staton Abbey. Cloth. Pages iv+417. 12×18.5 cm. 1955. Philosophical Library, Inc., 15 East 40th Street, New York 16. N. Y. Price $6.50.

EXPERIMENTAL PSYCHOLOGY. A SERIES OF BROADCAST TALKS ON RECENT RESEARCH, by A. J. Watson, Harry Kay, J. A. Deutsch, B. A. Farrell, Michael Argyle, Oldfield. Cloth. xi+66. 12×18.5 cm. 1955. Philosophical Library, Inc., 15 East 40th Street, New York 16, N. Y. Price $2.75.

LAPLACE TRANSFORMS FOR ELECTRICAL ENGINEERS, by B. J. Starkey, Dipl. Ing., A.M.I.E.E., *Head of the Radio Department, Royal Aircraft Establishment, Farnborough.* Cloth. 279 pages. 13.5×21.5 cm. 1955. Philosophical Library, Inc., 15 East 40th Street, New York 16, N. Y. Price $10.00.

COLLEGE CHEMISTRY, Second Edition, by Linus Pauling, *Professor of Chemistry, California Institute of Technology.* Cloth. Pages xii+685. 15×23.5 cm. 1955. W. A. Freeman and Company, San Francisco, Calif. Price $6.00.

FÜNFSTELLIGE TAFELN DER KREIS -UND HYPERBELFUNKTIONEN, by Dr.-Ing. Keiichi Hayashi. Cloth. Pages 182. 15×24 cm. 1920, Reprint 1955. Walter de Gruyter & Co., Berlin W 35, Germany. Price $3.00. May be purchased from Stechert-Hafner, Inc., 31 East 10th Street, New York 3, N. Y.

TEACHING ARITHMETIC WE NEED, Grade 4, Manual, by Guy T. Buswell, *University of California, Berkeley, California;* William A. Brownell, *University of California, Berkeley, California;* and Irene Sauble, *Detroit Public Schools, Detroit, Michigan.* Paper. 357 pages. 17.5×23 cm. 1955. Ginn and Company, Statler Building, Boston 17, Mass. Price $1.60.

TEACHING ARITHMETIC WE NEED, Grade 3, Manual, by Guy T. Buswell, *University of California, Berkeley, California;* William A. Brownell, *University of California, Berkeley, California;* and Irene Sauble, *Detroit Public Schools, Detroit, Michigan.* Paper. 354 pages. 17.5×23 cm. 1955. Ginn and Company, Statler Building, Boston 17, Mass. Price $1.60.

LABORATORY EXPERIMENTS IN GENERAL CHEMISTRY, by J. A. Campbell and L. E. Steiner, *Professors of Chemistry, Oberlin College.* Paper. Pages viii+216. 20×27 cm. 1955. The Macmillan Company, 60 Fifth Avenue, New York 11, N. Y. Price $3.40.

LABORATORY EXPLORATIONS IN ZOOLOGY, Third Edition, by Karl A. Stiles, M.S., Ph.D., *Professor and Head of the Department of Zoology, Michigan State College, East Lansing, Michigan.* Paper. Pages xi+283. 20.5×27.5 cm. 1955. The Macmillan Company, 60 Fifth Avenue, New York 11, N. Y. Price $3.75.

PRACTICAL LABORATORY CHEMISTRY, A MANUAL FOR BEGINNERS, by Horace G. Deming, *Research Associate, Department of Chemistry, University of Hawaii.* Paper. Pages xi+209, 21×28 cm. 1955. John Wiley and Sons, Inc., 440 Fourth Avenue, New York 16, N. Y. Price $3.50.

THE DYNAMICAL THEORY OF GASES, Fourth Edition, by J. H. Jeans, D.Sc., LL.D., F.R.S. Paper. 444 pages. 14×23.5 cm. Dover Publications, Inc., 1780 Broadway, New York 19, N. Y. Price $2.00. Cloth $3.95.

ALMOST PERIODIC FUNCTIONS, by A. S. Besicovitch, *Fellow of Trinity College, Cambridge.* Paper. Pages xiii+180. 13×20.5 cm. 1954. Dover Publications, Inc., 1780 Broadway, New York 19, N. Y. Price $1.75. Cloth $3.50.

RIDER'S SPECIALIZED AUTO RADIO MANUAL, (Vol. 6-A, Motorola). Paper. 208 pages. 21.5×28 cm. 1955. John F. Rider, Publisher, Inc., 480 Canal Street, New York 13, N. Y. Price $3.00.

ADVANCED DYNAMICS OF A SYSTEM OF RIGID BODIES, Sixth Edition, by Edward John Routh, Sc.D., LL.D., F.R.S., *Fellow of the Senate of the University of London.* Paper. Pages xiv+484. 13×20.5 cm. 1955. Dover Publications, Inc., 1780 Broadway, New York 19, N. Y. Price $1.95. Cloth $3.95.

THE CONTINUUM AND OTHER TYPES OF SERIAL ORDER, by Edward V. Huntington, *Associate Professor of Mathematics in Harvard University,* Second Edition. Paper. Pages vii+82. 13×20.5 cm. 1955. Dover Publications, Inc., 1780 Broadway, New York 19, N. Y. Price $1.00. Cloth $2.75.

THE A.R.R.L. ANTENNA BOOK, Seventh Edition, prepared by the Headquarters Staff of the American Radio Relay League. Paper. 344 pages. 16×24 cm. 1955. American Radio Relay League, West Hartford 7, Conn. Price $2.00 in the United States Proper, $2.25 elsewhere.

HANDBOOK OF 630-TYPE TV RECEIVERS, by Simon S. Miller, *Chief Engineer* and Howard Bierman, *Senior Engineer.* Paper. Pages vi+194. 14×22 cm. 1955. John F. Rider, Publisher, Inc., 480 Canal Street, New York 13, N. Y. Price $3.50.

THE CHEMICAL INDUSTRY FACTS BOOK, Second Edition, prepared by The Manufacturing Chemists' Association. Paper. Pages xii+148. 14.5×23 cm. 1955. Manufacturing Chemists' Association, 1625 Eye Street, N. W., Washington 6, D. C. Price $1.00.

BULLETIN BOARDS FOR TEACHING, by Charles H. Dent, *Associated Professor of Curriculum and Instruction and Coordinator of Student Teaching, College of Education. The University of Texas;* Ernest F. Tiemann, *Director, Visual Instruction Bureau, The University of Texas;* and designed by Nancy M. Holland, *Audio-Visual Specialist, Visual Instruction Bureau, The University of Texas.* 38 Pages. 15×23 cm. 1955. The Visual Instruction Bureau, Division of Extension, The University of Texas, Austin 12, Texas. Price $1.00.

F-M LIMITERS AND DETECTORS, edited by Alexander Schure, Ph.D., Ed.D. Paper. Pages iv+44. 14×21.5 cm. 1955. John F. Rider, Publisher, Inc., 480 Canal Street, New York 13, N. Y. Price 90 cents.

STATE ACCREDITATION OF HIGH SCHOOLS PRACTICES AND STANDARDS OF STATE AGENCIES, by Grace S. Wright. Bulletin 1955, No. 5. Pages iv+81. 14×23 cm. Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C. Price 30 cents.

SCIENCE TEACHING IDEAS II, edited by Abraham Raskin, *Associate Professor of Physiology and Coordinator of the Sciences, Hunter College, New York City.* Paper. 47 pages. 21.5×28 cm. 1955. National Science Teachers Association, 1201 Sixteenth Street, N. W., Washington, D. C. Price $1.00.

ABSTRACTS OF SCIENCE TEACHING IDEAS, prepared by the Publications Committee of the National Science Teachers Association, Abraham Raskin, Chairman. Paper. Pages iii+23. 15.5×22.5 cm. 1955. National Science Teachers Association, 1201 Sixteenth Street, N. W., Washington 6, D. C. Price $1.00.

EXPERIMENTAL ELECTRONICS FOR THE BEGINNER, by Lewis G. Blevins and Leonard R. Crow, *Universal Scientific Company.* Part I. Paper. 366 pages. 19.5×28 cm. 1955. Universal Scientific Company, Inc., 1102 Shelby Street, Vincennes, Ind. Price $3.60.

THE ELEMENTS OF THE THEORY OF REAL FUNCTIONS, Third Edition, by J. E. Littlewood, F.R.S., *Fellow of Trinity College, Cambridge,* and *Late Rouse Ball Professor of Mathematics.* Paper. Pages vi+71. 13×20.5 cm. 1954. Dover Publications, Inc., 1780 Broadway, New York 19, N. Y. Price $1.35, Cloth $2.85.

BOOK REVIEWS

FUNDAMENTALS OF ELECTRICAL ENGINEERING BASED ON THE RATIONALIZED M.K.S. SYSTEM OF UNITS, by Edward Hughes, *Formerly Vice-Principal and Head of the Engineering Department, Brighton Technical College,* Cloth. Pages xiv+470. 11.5×18.5 cm. 1954. Edward Hughes, 16 Tongdean Avenue, Hove 4, Sussex, England. Price 12s. 6d.

This book is a sequel to the more elementary and introductory text: *Principles of Electricity* by Morely and Hughes which was first published in 1953. Students who have mastered the contents of this book will have no difficulty with the more recent text by Hughes. The M.K.S. system of units is used throughout both texts but the definitions and explanations are also fully given in the more advanced text. More than 300 diagrams are used throughout to illustrate and explain the principles discussed. Following each theoretical discussion is a problem completely worked out and explained, so that the student is given the practical application of the theory as each step is taken. At the close of each chapter

a long list of problems is given covering the work of the chapter and previously discussed theory. Most of these questions have been taken from examination papers previously used. Tables of logarithms and antilogs are given and answers to the problems given to slide rule accuracy. Fifteen chapters compose the book. They are The Electric Circuit, Electromagnetism, Electrostatics, D.C. Generators and Motors, Single-Phase Circuits, Three Phase Circuits, Transformers, Alternators, Production of a Rotating Magnetic Flux, Alternators (continued), Synchronous Motors, Induction Motors, Thermionics, Electric Lamps and Illumination, and Symbolic Notation. It is an excellent textbook, clear and practical.

G. W. W.

GENERAL PRINCIPLES OF GEOLOGY, by J. F. Kirkaldy, D.Sc., F.G.S., *Reader in Geology, University of London*, Cloth. 327 pages. 15×23 cm. 1955. Philosophical Library, Inc., 15 East 40th Street, New York 16, N. Y. Price $6.00.

The author of a book of this type has a big job on his hands in selecting the fundamental material and eliminating the many interesting parts of his subject necessary to hold the book to a reasonable number of pages. Here six fundamental sections are discussed. (A) A short section on Basic Principles explaining stratification, folds, faults and rocks; (B) a much longer section discusses Physical Geology and Geomorphology, explaining weathering and transportation of the weathered material, the work of rivers, glaciation, sea action, the semi-arid and arid regions, and denudation chronology; (C) includes Petrology and Mineralogy, giving conditions for the formation of rocks and minerals, a chapter on the identification of minerals, the igneous and metamorphic rocks and their uses, the sedimentary rocks and their uses; (D) a short section on the Composition and Origin of the Earth; (E) Historical Geology, explaining the geological timescale, a study of fossils, and a brief geological history of the British Isles; (F) a short chapter on Economic Geology. Appendix I gives the interpretation of geological maps and Appendix II gives a list of books for reference and further reading. This is distinctly a book for the British Isles but contains much that is well discussed for students in all parts of the world.

G. W. W.

TREATISE ON INTEGRAL CALCULUS WITH APPLICATIONS, EXAMPLES AND PROBLEMS, by Joseph Edwards, M. A., *Formerly Fellow of Sidney Sussex College, Cambridge, and Principal of Queen's College, London*. Cloth. Vol. I, pages xii+907. Vol. II, pages xv+980. 11.5×20 cm. 1954. Chelsea Publishing Company, 552 West 181 Street, New York 33, N. Y. Price $6.50 per volume.

Individuals and libraries who have been unable to obtain a copy of this work, originally issued in 1921, and reprinted (in the case of volume I) in 1930, will welcome the appearance of these volumes, which appear to be photostatic reproductions.

These volumes were issued as a text for advanced students in English universities. Very few, if any, courses are offered in colleges or universities in the United States for which these would be considered suitable texts. It takes only casual examination of the books to see the contrast between what is offered in English schools (or, to be fair, what was being offered in 1921) and in universities in the United States. Although the broad statement is perhaps unfair, the content of these two volumes might be characterized by saying that possibly greater attention is paid to technical points of manipulation than to underlying theory than is the case with some of our advanced works. As examples of this, one might mention integration by substitution, reduction formula (at least 140 pages), extensive work on the evaluation of definite integrals, etc.

Primarily these volumes will be purchased for reference work. It is doubtful if there is any work available in which so much detail is given, or where one may find more help in the evaluation of a "tricky" integral. An interesting feature is

the large number of problems, with (in many cases) sources to the English university examinations in which they appeared.

CECIL B. READ
University of Wichita

TRANSFORM CALCULUS WITH AN INTRODUCTION TO COMPLEX VARIABLES, by E. J. Scott, *Assistant Professor of Mathematics, University of Illinois.* Cloth. Pages ix+330. 16×24 cm. 1955. Harper and Brothers, 49 East 33d St., New York 16, N. Y. Price $7.50.

This is a text on the advanced undergraduate or graduate level, with applications in the fields of physical science and engineering. As might be expected, a considerable amount of mathematical maturity is needed to handle the material—probably differential equations as a minimum, at points such topics as Fourier series are mentioned as though the reader was familiar with the topic.

The approach is from the point of view of complex variable theory. In the first chapter, dealing with this theory, the author introduces line integrals of complex functions, then proceeds through Cauchy's residue theorem to applications in the evaluation of real definite integrals. In the preface the author points out that he feels this the most satisfactory approach, although perhaps not the easiest. Among subjects treated are the applications of Laplace transforms to linear differential equations and to linear partial differential equations; difference equations, asymptotic series, integral equations, matrix algebra and its application to systems of linear differential equations. There are a great many applications to engineering problems.

There are problems at the end of each of the ten chapters, averaging more than fifteen to a chapter, which seems ample. In the appendices there are tables of various transforms, over 100 of these are Laplace transforms.

Any instructor at all interested in approaching the subject from the point of view of this book should consider this as a class text, even if another approach makes the book unsuitable as a text, it is of value for reference material. Unfortunately for this use, the index is incomplete—several topics covered in the book are not mentioned in the index. At least one error was noted in the index—integro-differential equations seem to be discussed on page 271, not 277.

CECIL B. READ

THE THEORY OF NUMBERS, by Burton W. Jones, *Professor of Mathematics, The University of Colorado.* Cloth. Pages xi+143. 15×22 cm. 1955. Rinehart and Company, Inc., New York, N. Y. Price $3.75.

In the preface the author states that this text is planned both for the prospective elementary or secondary school teacher and for the student who is majoring in mathematics and possibly beginning graduate work. In spite of what may be first thought to be incompatible objectives, it would seem that to a remarkable degree the book accomplishes the author's purpose.

The first chapter deals with the development of the number system, with a rather thorough treatment, yet one within the grasp of the student. There is a good discussion of the decimal system, with reference to other bases than ten. The second chapter takes up repeating decimals and congruences, and is perhaps on a little more mature level. The third chapter deals with Diophantine equations, both linear and quadratic. Remaining chapters take up such topics as continued fractions, nonlinear congruences, and quadratic residues.

Particularly in the first portion of the book emphasis is placed upon points or topics which will enrich the teaching of mathematics—for example, certain types of puzzle problems, methods which may be used to provide integral solutions to problems, reasons why we may not "define" the result of division by zero as a new number called "infinity."

Problems are rarely of a routine type, but rather require the student to show the details of some demonstration, or carry out certain lines of reasoning. A

striking number of the exercises start with some phrase such as: Prove . . . ; Show how . . . follows . . . ; What properties hold for . . . ; Extend . . . ; Why does . . . follow? Give an example of. . . . Probably for this reason, no answers are provided. In general, the number of exercises seems ample for ordinary class use.

Instructors have different ideas of the suitability of a text for their purposes; this reviewer has encountered few books about which he felt as he does about this one—I should like to use this as a text, without modification.

CECIL B. READ

MATHEMATICS FOR ENGINEERS, PART I, *including* ELEMENTARY AND HIGHER ALGEBRA, MENSURATION AND GRAPHS, AND PLANE TRIGONOMETRY, by W. N. Rose, B.Sc. Eng. (Lond.), *Late Head of Mathematics Department at the Borough Polytechnic Institute*. Ninth Edition. Pages xiv+527. 15×22.5 cm. Chapman and Hall, Ltd., 37 Essex Street W. C. 2, London. 1955. Price 21 shillings.

This is the ninth edition of a work which first appeared in 1918. As the title indicates, it emphasizes the practical applications, but by no means to the exclusion of a sound theoretical basis. As might be expected in an English text, there are some variations in symbolism and some words which seem odd to the American reader—for example, *frustra* of pyramids and cones. Items which seem to this reviewer somewhat out of the ordinary and of distinct merit include: the curve of sines and curve of cosines (*not* the sine curve or cosine curve) on page 234; the discussion of various methods for allowing for depreciation, in connection with arithmetic and geometric progressions; a chapter on areas of irregular curved figures, including a discussion of the planimeter, the computing scale, the trapezoid and Simpson's rules; a chapter on the calculation of earthwork voiumes; a chapter on "The construction of practical charts" which gives a good introduction to nomography and alignment charts.

This reviewer found a few minor points to which he takes exception: in the definition of zero and negative exponents there is no restriction that the base must not be zero; it seems a little odd to find the ellipse and parabola, for example, classed as "difficult curve equations"; angles seem to start from the north as zero, rather than the east.

Although it is doubtful that this would be selected as a text in one of our American schools, the material covered, together with the large number of examples to be worked, make it worth adding to the library for reference purposes. As a single example, Chapter X—The determination of laws—furnishes such supplementary material on empirical equations and curve fitting; likewise the appendix describes a cylindrical slide rule. Do not be misled by the sub-title, much more is included than it might imply.

CECIL B. READ

MATHEMATICS FOR HIGHER NATIONAL CERTIFICATE, A TEXT BOOK FOR THE USE OF FIRST YEAR (A1) STUDENTS, by S. W. Bell, B.Sc., and H. Matley, B.Sc., *Lecturers in Mathematics at Norwich City College*. Volume I. Cloth. Pages xiii+293. 15×22 cm. Cambridge, University Press. 1955. Price $2.75.

As indicated by the title, this text is definitely written for British schools. Material covered is largely that of a second semester of calculus, together with a considerable amount of differential equations and a chapter on harmonic analysis. As might be expected, the terms and symbolism sometimes differ from the usage in the United States (small delta where we use capital delta, an unusual notation for approaching a limit from lower values introduced on page 16, *thrust* where many books use *force*, and similar minor variations), but these cause the reader no difficulty. This reviewer objects to the choice of scale in Figures 12 and 13, on pages 45–46, and to the fact that no scale is indicated on the x-axis on page 47. The problem lists seem quite short.

At several places one gathers the impression that a reason for introducing some

material is that it is expected to be found on a certain examination, or is a part of a specified course which would be meaningless to the student in the United States. Rather obviously the book is not the best choice for a text; it may serve as supplementary problem material, but the content is not markedly different than many other texts. This by no means implies lack of merit in the text—merely that it was primarily written for use in another country. In fact, the treatment is in general very sound, and there are many good examples of application of the subject matter.

CECIL B. READ

THE HAND PRODUCED BOOK, by David Diringer, D.Litt., (Flor.) M. A. (Cantab.), *University Lecturer, Cambridge, England.* Cloth. Pages xii+591. 16.6×23.6 cm. 1953. Philosophical Library, Inc., 15 East 40th Street, New York 16, New York. Price $15.00.

This is a book about books. It may sound a bit paradoxical to speak of prehistoric books. The author characterizes them as "books in embryo." From the uncertainties of oral tradition and primitive mythology he traces the evolution of "books" to our modern library's "handsome volumes."

As a sort of subtitle, the caption is, "A companion volume to 'The Alphabet'." A third volume is promised on "Illumination and Binding of the Book" to follow this. "The Alphabet," published in 1948, has already passed through three printings. Its production is said to have established David Diringer as one of Cambridge's leading scholars.

Here, in eleven chapters, aided by 185 figures and a thirty-eight-paged, double-columned index, the author summarizes and catalogues modern research relative to the development of the book.

Chapter titles give the sequence of treatment. They are: Book in Embryo; Earliest Systems of Writing; Clay Tablet Books; Papyrus Books; From Leather to Parchment; Greek-Latin Book Production; The Book Follows Religion; Outlying Regions (I): Ancient Middle East, Central and Southern Asia; (II) Far East and Pre-Columbian America; Anglo-Celtic Medieval Books (Including: Conclusion; Fate of Books) and an Appendix on Writing Equipment.

The presentation is non-technical but copiously annotated. Chapter and general bibliographies make it readily helpful to the student who is more than passingly interested in this field. It is hardly a book one would read "from cover to cover." However, this reviewer did find, in sections he sampled, an interest-holding quality not usual for volumes of its scholarly character. Its appeal will be to humanists and librarians rather than mathematicians and scientists. Those interested in the history of religion will find much reward for reading the chapter on "The book follows religion."

B. CLIFFORD HENDRICKS
Longview, Washington

LOOKOUT FOR THE FOREST, A CONSERVATION STORY, by Glenn O. Blough, *Associate Professor of Education, University of Maryland.* Pictures by Jeanne Burdick. Cloth. Pages 48. 19.0×26.0 cm. 1955. McGraw-Hill, 330 West 42nd St., New York 36, N. Y. Price $2.25.

People living on the plains have slight appreciation of the disaster a forest fire can leave in its wake. It is the menace of such catastrophes that prompts rigid rules of dry season logging and inspires slogans, "Keep Washington Green" and of "Smokey Bear."

Efforts to educate seek to reach both the tourist public and the resident children, especially through the schools. The book under review is one means to that end.

As its sub-title intimates, its author has a more inclusive program in mind. By simply phrased text, by generous use of drawings in color the third or fourth grade boy or girl may here get lessons on soil, forest wild life, forest growth, and forest products as well as how to fight insect pests and forest fires.

Tad is the boy, Mr. Riddle, his dad, and Mike, the forest ranger, are the chief actors. The stage is, partly, atop the 130 foot lookout tower but the performances encompass both the dad's tree farm and the State Forest before the story finds an end.

B. CLIFFORD HENDRICKS

HOT METAL MAGIC. Illustrated in colors. Paper. Pages 34. 19.0×26.0 cm. Electro Metallurgical Company, 30 East 42nd St., New York 17, N. Y. Free.

A splendidly illustrated trade-booklet giving the ferro-alloys an entertaining but impressive "once over." Chemistry teachers will certainly want, at least, a reference copy for its excellent charts.

B. CLIFFORD HENDRICKS

BETTER TEACHING THROUGH ELEMENTARY SCIENCE, by Julian Greenlee. Paper. xii+204 pages. 14×21.5 cm. 1954. Wm. C. Brown Co., Inc., Dubuque, Iowa.

Dr. Greenlee, who is well-known in the field of elementary science, has made a unique contribution to the methodologies that have been published for that area. The book does not have the psychological organization ordinarily found in books of this type. Rather, it presents a philosophy of elementary-science teaching through a series of anecdotes that describe the activities that take place in a first-grade classroom. Through these anecdotes, the trials and tribulations of a teacher who attempts to teach elementary science are clearly depicted.

Perhaps the most important theme in this publication is the one that shows the growth of a philosophy of science teaching in several teachers to whom science is a new and somewhat unknown field. Their early concerns with teaching science are described, and their slow growth in understanding science education is well-indicated through the day-to-day problems they face. The gamut of these problems, involving laboratory work, audio-visual aids and outdoor science is emphasized by means of informal presentations of their daily classroom activities.

There are many, well-schooled in science education, who will suggest that many of the anecdotes are superfluous and redundant. For those who are well-qualified in science education, the reviewer would agree.

However, for the vast number of elementary teachers for whom science is a frightening Colossus this book has great potential value. It will console those who have done their best and failed. It will encourage many who have believed their efforts have been in vain. Many may see in the experiences described, a paraphrase of their own efforts; and may see ways to improve them.

For the inexperienced elementary teacher, or the experienced one in doubt about science, it can be most helpful.

GEORGE G. MALLINSON
Western Michigan College, Kalamazoo

ELECTRONICS FOR YOUNG PEOPLE, New Revised Edition, by Jeanne Bendick. Cloth. 189 pages. 13.5×20 cm. 1955. Whittlesey House, McGraw-Hill Book Company, Inc., 330 West 42nd Street, New York 36, N. Y. Price $2.75.

This new revised edition has been enlarged to include additional information on atomic energy. It is primarily for children beyond the fifth grade. This fascinating book begins with a definition of an electron and proceeds to electricity, electron tubes, waves and the early beginnings of electronics.

After seven chapters of simple explanations of electronic devices, the book proceeds to describe the application of electronics to objects familiar to the average teen ager. These objects include fluorescent lights, facsimile broadcasting, X-rays, photo-tubes, electron microscope, strobotron, radio and television.

The last two chapters deal with atomic energy, simplified in keeping with the preceding material, but not lacking in detail for inquiring youngsters.

Although not a text, a glossary is included as well as a complete index. The most significant part of this publication is the effectiveness of the action packed

diagrams used to explain electronic equipment and describe various phenomena. The effectiveness is probably due to the fact that the author was determined to get her ideas across to her young readers. Each illustration has a purpose.

Another point of interest is the insertion of short historical sketches of the major discoveries and inventions in the field of electronics.

This book is easy to read, with its large type and smooth flowing explanations. No subject is expanded into boredom for the young reader. It is easy to read Science, for the science shelf.

JOHN D. WOOLEVER
Mumford High School
Detroit, Michigan

YOU AND SCIENCE, by Paul F. Brandwein, *Chairman, Science Department, Forest Hills High School, New York, N. Y.;* Leland G. Hollingworth, *Director of Science, Brookline Public Schools, Brookline, Massachusetts;* Alfred D. Beck, *Science Supervisor, Junior High School Division, Board of Education, New York City;* and Anna E. Burgess, *Directing Principal, Board of Education, Cleveland, Ohio.* Cloth. 630 pages. 15.5×23.5 cm. 1955. Harcourt, Brace and Company, New York, 17, N. Y. List Price $3.92.

Although the usual General Science subjects are covered in this revised text, they revolve principally around the phenomena associated with objects familiar to the teen ager. In most chapters, spectacular and popular topics of the times introduce the subject or terminate it, as in the case of radioactivity, space and electricity. This is handled well as it stimulates the student to study the new unit or it whets his appetite for more of the same after the unit is finished.

Each chapter averages 75 to 80 pages, culminating in a review of the vocabulary, self testing exercises, suggested activities and a list of references. Science careers in the field of the subject covered is a novel addition.

New words are pronounced and defined as introduced. Each unit is liberally sprinkled with experiments and some historical sketches of early experiments. At least one picture or diagram is found on each page but not merely for decoration, as each presents a problem or attempts to clarify some important point.

Two chapters are unusual for a general science text. An early chapter deals with "Ways of Learning," a bit of practical psychology to aid the student in his study habits. The other is a relatively detailed coverage of reproduction and heredity. This is always of interest to teen agers but not always handled well, in many texts.

Science hobbies are encouraged by occasional suggestions for experiments, etc., for those who may want to pursue the subjects further.

Any student mastering this volume will do well in any science course he might choose later. However it would take at least a ful year with almost daily meetings, to have a ninth grader derive full value from the authors' efforts.

JOHN D. WOOLEVER

HEALTH AND SAFETY FOR YOU, by Harold S. Diehl and Anita D. Laton. 515 pages. 1954. McGraw-Hill Book Company, Inc. $3.76.

This is a conventional text primarily for use in the senior grades. In the preface, the authors emphasize that the presentation and vocabulary are suitable for the grade level for which it was written. The "Health" is an over all view of physiology, anatomy and some hygiene. The "Safety" is dealt with in discussions of disease prevention, driving, home and play accidents. Simple First Aid is introduced early in a chapter entitled "What to do in Emergencies." There are twenty-eight chapters which would take a full year to cover with any thoroughness. Each subject under consideration is covered from a practical viewpoint directed at helping the teen ager. This is the most commendable feature of the book. Particular emphasis is placed on explanations rather than on rules and facts.

Although all subjects found in the usual texts of a similar nature are included,

the authors were wise in exploring the subjects of skin, hair and mental health, subjects of great interest to teen agers. A subject somewhat neglected was that of narcotics and stimulants. The wisdom of this shortchanging is controversial.

Each chapter terminates in a series of questions and a list of suggested activities. Illustrations include photographs and clear diagrams, each with a purpose. There are some humorous but effective cartoons also.

Three units most worthy of mention are: "Your Health Inventory" a detailed step by step explanation of an average physical examination. It explains the what and why of everything done during a "check up." "Opportunities for Service in the Field of Health" is an excellent chapter that might enlist some recruits for the field.

The final chapter introduces the future citizen to "Health Services for All People," a subject many may benefit from. In spite of the many health agencies existant, relatively few people take full advantage of the available services.

At the end of the book there are lists of books for further reading. A simple glossary, index and a short list of films made for use with the book are also included.

JOHN D. WOOLEVER

EXPLORING MARS, by Robert S. Richardson. Cloth. 261 pages. 13.5×20 cm. 1954. McGraw-Hill Book Company, Inc. New York. $4.00.

The title of this book may be very misleading to those who have been struck by the large number of science fiction publications. This is an appealing scientifically accurate book written by an astronomer at the Mount Wilson and Palomar Observatories in California.

It begins with a short history of early astronomers who were concerned with our nearest neighboring planet. This is followed by a discussion of present day and contemplated future space travel. A great amount of detail is included in charts relative to problems to be faced in making any extensive interplanetary trips. Even a Martian calendar has been devised.

Physiographic conditions, Martian atmosphere, temperature and gravity are covered with an extensive analysis of the kinds of life possible on the planet.

Martian canals and another controversial subject, flying saucers are treated at length. To keep the book from being entirely encyclopedic, the author gives simple directions for making personal observations of Mars with specific dates, locations and sky maps.

For comparison, a few short chapters are devoted to the other planets of the solar system.

There is a series of excellent astronomical photographs and quite a number of meaningful diagrams.

It is skillfully written for both children and adults. As a book on the school library shelf, it will save many science teachers innumerable headaches attempting to clarify allegations, half truths and misconceptions rampant in many of the science fiction stories read by students.

JOHN D. WOOLEVER

TWO EARS OF CORN, TWO BLADES OF GRASS, by D. H. Killeffer. 139 pages. 15×23 cm. 1955. D. Van Nostrand Co., Inc. New York. Price $4.00.

Mr. Killeffer sets out to allay the fears of those who believe that in a short time, the earth will be over populated, and with our expanding needs, we will shortly use up all our food and mineral resources. As he points out, this fear is not new, but one primarily started by Malthus and still going strong today.

The author's main argument is based on the ingenuity of man, his ability to solve new problems as they arise and his adaptability to his environment.

Chemistry of course is the means whereby man has solved most of the major problems to date and the first example of this is the history of "synthetics" and what they have done for us. The popular misconception that synthetics are inferior is another sore point of the author's. Another intriguing chapter is de-

voted to placating those who believe we will soon run out of metals. This worry too, is logically erased.

The remainder of the book revolves about the ramifying problems of food and power. The author demonstrates how chemistry has solved our past food and medical problems and is presently working on present ones. Accomplishments in Atomic energy and petroleum show what man has done to fulfill his need for energy to produce and improve his standard of living.

Many historical anecdotes dot this informative book, as well as numerous photographs and diagrams illustrating various chemical developments.

The need for keen minds and trained scientists in order to continue our progress and solve our ever increasing problems is not overlooked. Opportunities for science careers are brought out.

This optimistic answer to present day Malthusiasts makes pleasant reading for student and adult alike. It would be a valuable supplement to a high school chemistry collection.

JOHN D. WOOLEVER

A HISTORY OF THE THEORIES OF AETHER AND ELECTRICITY 1900–1926, by Sir Edmund Whittaker, F.R.S., *Honorary Fellow of Trinity College, Cambridge.* Cloth. Pages xi+319. 15×24 cm. 1954. Philosophical Library, Inc., 15 East 40th Street, New York 16, N. Y. Price $8.75.

This latest work of the renowned English theoretical physicist is entitled in a way which may almost be considered understatement. Sir Edmund Whittaker is well known by readers of popular interpretations of science and greatly respected by men in the community of theoretical physics. Many a generation of graduate students has labored over his "Analytical Dynamics" and from it gained new insight into the beauty of formulations of mechanics.

This present volume deals with the principal theories of physics of the early twentieth century and especially of the turbulent period when both quantum mechanics and relativity were being formulated. Professor Whittaker writes with enchanting style and yet with well documented detail. In general each topic is introduced in descriptive manner but as the details are unfolded the author does not hesitate to utilize relatively advanced mathematical formulation of the theories. Because of this choice of organization both the undergraduate student of physics as well as the graduate student may find the book useful. The experienced teacher will find the book stimulating because of the elegance of presentation of topics which are the foundation stones in the training of the physicist in 1955.

The book contains nine chapters which in general cover the fields of classical modern physics, relativity, electrodynamics, and quantum mechanics. Thus it is more than a history although historical in approach and certainly concerned with ether and electricity in their wider meaning.

GEORGE BRADLEY
Western Michigan College
Kalamazoo, Mich.

MATHEMATICS FOR THE SECONDARY SCHOOL, by William David Reeve, *Professor Emeritus of Mathematics, Teachers College, Columbia University.* Cloth. Pages xii+547. 15.5×23.5 çm. Henry Holt and Company, New York, N. Y., 1954. Price $5.95.

The book treats some of the main teaching problems in mathematics for the secondary school that have been considered in the last quarter of a century. It gives some conclusions that generally have been reached, the questions that need further study, and some of the methods that make such a study effective. Also, suggestions are made for deciding upon the place of mathematics in secondary education, for determining the nature of the curriculum in mathematics, for obtaining the best methods of instruction, and for the evaluation of the same.

The text begins by a consideration of The Place of Mathematics in Secondary Education in which the reorganization of secondary school mathematics and the

work of various commissions, along with other topics, are considered. The chapters, in turn, are devoted to Planning the Curriculum and to Modern Curriculum Problems in Secondary Mathematics.

The need for teacher training, the objectives of student teaching, the eligibility for student teaching, etc. as treated in the chapter on The Training of Teachers of Secondary Mathematics, to the reviewer, is one of the most interesting and valuable sections in the book for the prospective teacher. The author maintains a good balance in the relation between the academic and the professional training of a mathematics teacher.

Lesson Types and Methods of Teaching, the Teaching of Informal Geometry in Junior High School, the Teaching of Algebra, the Teaching of Demonstrative Geometry are all exceptionally well treated. In the section in algebra the function idea is brought into focus. On page 258 the author states that "The function concept is the most important idea to be stressed throughout the work in algebra and trigonometry." Other topics considered are as follows: Mathematics for the Citizen, The History and Teaching of General Mathematics, the Mathematics Classroom and Its Equipment, and the Future of Mathematics Education in the Secondary School.

Questions and topics for discussion are given at the end of each chapter and serve as useful aids to instruction. Many references are given throughout the book and the book is carefully indexed.

This publication is a real contribution to teacher education in the field of mathematics and rates among the best of its type. Written by an author who devoted many fruitful years to mathematics education, the book deserves a place in the library of every mathematics teacher.

CLYDE T. MCCORMICK
Illinois State Normal University
Normal, Illinois

HOW TO USE TEST PROBES, by Alfred A. Ghirardi and Robert Middleton. Paper. Pages iv+172. 14×21.5 cm. 1954. John F. Rider Publisher, Inc., 480 Canal Street, New York 13, N. Y.

The immediate need for this book, as stated by the authors in the preface, arises from the increasing use of volt-ohm-milliammeters, vacuum tube voltmeters, and oscilloscopes in troubleshooting and adjusting complex electronic circuits where the instrumentation requirements often exceed the capabilities of conventional commercial test instruments. Auxiliary devices in the form of probes are widely used to extend the range of, or add new functions to these conventional test instruments. ". . . it is important for every service technician to understand thoroughly the function and basic theory of operation underlying all types of probes and also the correct methods of using them to obtain the maximum amount of service they are capable of giving. . . . It is the purpose of this book to present the required information in a simple and thorough manner that will make the subject easily understandable to both practicing technicians and beginners alike, so that they will know how to use test instrument probes correctly."

The authors discuss the principles of operation, the requirements, the design features, and the methods of use of six chief classes of test probes:

1. Resistive high-voltage DC probes used primarily for extending the range of volt-ohm-milliammeters and vacuum tube voltmeters
2. Capacitance-divider high-voltage AC probes for extending the voltage ranges of oscilloscopes
3. Resistive circuit-isolation probes (the DC probe) used primarily for isolating the testing instrument from the test circuit
4. Compensated RC (low capacitance) and cathode follower circuit-isolation probes
5. Rectifying probes for use with a vacuum tube voltmeter in measuring alternating voltages

6. Demodulating probes for use in observing and measuring the modulation component of an amplitude-modulated voltage

The treatment of each aspect of the subject is quite concise and sufficiently thorough for the intended purpose. A minimum amount of mathematics is used in the developments. Many helpful illustrations and circuit diagrams are given.

This book is decidedly technical in nature. It should serve as an excellent reference source for more advanced electronic technicians and others who may have an interest in probes and their uses.

W. G. MARBURGER
Western Michigan College
Kalamazoo, Michigan

ALGEBRA ITS BIG IDEAS & BASIC SKILLS, by Daymond J. Aiken, *Head of Mathematics Department, Lockport Township High School, Lockport, Ill.* and Kenneth B. Henderson, *Professor of Mathematics Education, University of Illinois.* Book 1 pages xi+419. 1954. Price $2.84. Book 2 pages xii+397. 1954. Price $3.96. McGraw-Hill Book Company, Inc., New York, N. Y.

The first of these two books is a ninth grade algebra text and the second is an intermediate algebra. The two books have many features in common. Both have good format, style, and type size, all of which make for easy reading on the part of the student. Both make good use of italics, bold face type, and illustrations. Each is grouped around what the authors call big ideas. In Book 1 these are; general numbers, equations, signed numbers, dependence and mathematical relationship, graphical representation of algebraic quantities, exponents at work, and indirect measurement. In Book 2 these are; numbers and their uses, logarithms, equations, and functional relationships.

In Book 1 each chapter ends with review exercises, a chapter test, and a summary of things to remember. The authors place a great deal of emphasis on vocabulary, especially in the chapter summaries. However, this was one of the features that this reviewer thought needed improvement. The first expression listed in a summary was "algebraic numbers" and this reviewer could find no mention of it either in chapter one or in the index. Too often the word or expression in question would be in italics or bold face type in one sentence and the actual definition would come a sentence or two later. For example general numbers on pages 1 and 2, and exponents on page 11. Some of the definitions were entirely in bold face type, while others had the key word in bold face type or italics. This reviewer feels that a consistent practice in the treatment of definitions would help. The authors have used "comic" drawings to a good advantage throughout the book. Signed numbers are handled well for all fundamental operations except division. The rule for multiplication of signed numbers was developed using a number scale and the idea that multiplication is a short method of addition. Division might well have been handled in a similar manner by treating it as a short way of performing a series of identical subtractions. The authors consider the first 13 chapters to be a minimum course that could be supplemented for fast students with the section of supplementary topics. This reviewer does not feel that solution of quadratic equations by completing the square and by quadratic formula are only for the fast student but are part of a minimum course. If they were left out in Book 1, they would not be covered until chapter 6 of Book 2.

Book 2 starts each chapter with a statement of the aims of the chapter and ends with a review, test and summary. There is ample material for a full year course in Book 2, and with selective omission on the part of the teacher it would be suitable to use in a one semester course. The fourth big idea of the authors in this book, functional relationships, includes chapters on graphical representation, linear functions, quadratic functions, polynomial functions and trigonometric functions. The authors have done a good job here and have successfully introduced the terms delta x and delta y. They have not only pointed out that the ratio of delta y to delta x is a constant in linear equations, but have shown that the ratio of delta y prime to delta x is a constant in quadratics. They develop the

factor theorem, remainder theorem, and others, in the chapter on polynomial functions. The chapter on trigonometric functions defines the six trigonometric functions in terms of the acute angle, provides opportunity to become familiar with tables, and includes some problems of the indirect measurement type. They have also included a chapter on progressions and series.

In choosing a two book series or individual books one might well examine these books rather carefully.

DALE L. MARSHALL
Illinois State Normal University

FOREIGN TEACHING POSTS

Foreign Teaching Posts will be available in Army-operated schools in Germany, France, Japan and Okinawa for the 1956–57 school year. Applications will be accepted for high school positions from teachers who are prepared to teach in two major subject fields.

Qualifications include a bachelor's degree, 18 semester hours credit in education courses (including practice teaching), 15 semester hours preparation in each major field, a valid teaching certificate, and a minimum of two years recent experience. Age: Minimum—25, maximum—55.

Salary is $377 monthly with free transportation overseas and return. Rent-free living quarters are provided in most areas. Minimum tour of duty is one year.

Personal Interviews with qualified applicants will be conducted throughout the United States early in 1956. To assure consideration for the coming school year, inquiry should be made prior to January 1. For further information write to Overseas Affairs Division, Office of Assistant Chief of Staff, G-1, Personnel, Department of the Army, Washington 25, D. C.

RESEARCH GRANTS TO CARNEGIE

The U. S. Department of Defense has extended two research grants to the Carnegie Institute of Technology Department of Mathematics.

The larger grant, $31,388, was given by Army Ordnance for an overall mathematical analysis of electrical and mechanical systems. Research will be conducted under the direction of Professors A. E. Heins and R. J. Duffin.

The U. S. Air Force extended $6075 for research into the theory of various transformations in the analysis of variance. This project will be conducted under direction of Professor Edwin G. Olds.

ANNUAL MEETING OF THE NATIONAL COUNCIL OF GEOGRAPHY TEACHERS

The Annual Meeting of the Forty-first Year of the National Council of Geography Teachers will be held in Indianapolis, Indiana, November 25–26, 1955 The Claypool Hotel will serve as convention headquarters.

All geography teachers, administrators, and others interested are cordially invited to attend this meeting. Encourage your colleagues to attend with you and contribute to the success of the meeting.

M. Melvina Svec of New York State University, Oswego, New York, President of the National Council of Geography Teachers has prepared a varied and stimulating program based on the many suggestions she has received from N.C.G.T. members. The program has been designed to meet the needs and interest of geography teachers at all grade levels.

PAVE DIRT ROADS WITH PEANUT HUSKS

Indian scientists have found a way to pave dirt roads with peanut husks.

A dark liquid from peanut shells is the key material in the process that can turn rutted, muddy roads to hard, sturdy surfaces. The soil is first treated with

the dark liquid and dried. Then addition of the common salt, calcium chloride, forms a gelatinous mass in the soil that holds the tiny earth particles together.

Earths with high sand content harden best in the process, L. R. Chadda and S. R. Mehra of the Laboratory at Karnal, India, reported to the Highway Research Board.

The treatment increases the soil's resistance to friction and lowers its tendency to form mud when wet.

Chemically hardening dirt roads is a widespread practice in the United States to improve secondary arteries of travel. Furfural, a chemical from oat hulls, is one of today's most important stabilizing agents.

The Indian scientist said their process may not prove economical for large-scale road paving because of the cost of obtaining the husk liquid.

FILMSTRIPS FOR PRIMARY GRADES

Twenty-four simple experiments to help primary-grade children to develop a proper scientific attitude toward problem solving are pictured in the new series of six filmstrips in color, "First Experiments About Weather," produced by The Jam Handy Organization.

To help the child understand scientific concepts about the weather and its effects on everyday activities, detailed instructions shown on the screen by each filmstrip explain how simple experiments are set up and performed.

All of the experiments can be carried out in the classroom with the simple equipment available to all teachers. The concepts can be easily understood by the primary-grade child. The youngsters can make their own observations. They themselves can carry on the experiments.

The six filmstrips in color are: What Is an Experiment?, How Does Water Get Into the Air?, What Makes Things Dry Faster?, Where Do Clouds Come From?, What Is Wind?, and Why Is the Night Cooler Than the Day? The series is designed to help young people form good thinking habits and thus to prepare them for future scientific adventures.

The complete series is priced at $27. Individual filmstrips are $4.75. Distribution is through The Jam Handy Organization, 2821 East Grand Boulevard, Detroit 11, and through authorized Jam Handy dealers.

SPACE TRAVEL TO MAKE ASTRONOMY PRACTICAL SCIENCE

Ten times as many big telescopes and ten times as much astronomical research are needed in the world, Dr. Otto Struve, president of the International Astronomical Union, said in a speech delivered in Dublin, August 29.

Dr. Struve made the statement in his presidential address opening the 9th general assembly of the Union, which is being attended by astronomers from all over the world.

The noted University of California astronomer pointed out that, largely because of the stimulus it has given to the study of nuclear energy, astronomy is not now considered so "useless" as it was a quarter of a century ago.

"Moreover, in these days of serious consideration of such future developments as an artificial satellite of the earth, and even of space travel, it promises to become one of the useful sciences in a practical sense," Dr. Struve said.

The scientist pointed out that any astronomer can think of dozens of programs of observation that cannot now be provided with existing telescopes. The 200-inch Palomar telescope cannot handle all of the problems that remain to be tackled, he said. A 10-fold increase in new astronomical facts is needed to "feed" theoretical studies, he added.

Dr. Struve decried a disquieting increase in the disparity of astronomical effort in different countries. He urged small or war-disturbed countries to send scholars abroad for training in astronomy.

He also recommended that special efforts be made to induce able persons to enter the field, and that diversification in the construction of telescopes be planned to suit climatic and other conditions.

The Famous *Welchons-Krickenberger* ALGEBRAS and GEOMETRIES

A *New Solid Geometry* and *Trigonometry with Tables* have recently been added to the popular Welchons-Krickenberger line. Like the other W-K books, they split every process into simple, thoroughly taught steps, foresee and provide for beginners' difficulties and supply different levels of work for students' varying abilities. Every topic is clearly explained.

Sales Offices:
New York 11
Chicago 16
Atlanta 3
Dallas 1
Columbus 16
San Francisco 3
Toronto 7

Home Office:
Boston

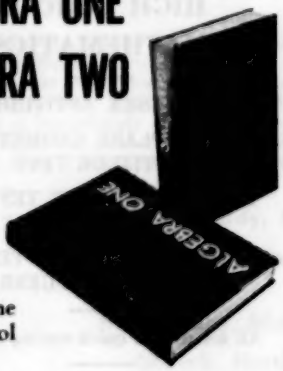
Please Ask for Circulars

GINN AND COMPANY

for easy teaching, lasting learning

by Rolland R. Smith
and
Francis G. Lankford, Jr.

ALGEBRA ONE
ALGEBRA TWO



Algebra for understanding
—easy step-by-step developments of basic algebraic ideas and operations, in terms of already familiar arithmetic concepts

Algebra for use
—practical, realistic applications, keyed to the interests and everyday experience of high school students

Write for full information

WORLD BOOK COMPANY
Yonkers-on-Hudson, New York
2126 Prairie Avenue, Chicago 16
Boston — Atlanta — Dallas — Berkeley

YOU NEED
MATHEMATICS CONTESTS

In Your School
To Stimulate Greater
Interest in Mathematics
Outline Sent on Request

NEW SCALE SLIDE RULES

FIELD WORK IN MATHEMATICS

By Shuster and Bedford $2.85

INSTRUMENTS FOR FIELD AND LABORATORY WORK IN MATHEMATICS

VISUAL AIDS AND MODELS

Send for Literature and Prices

YODER INSTRUMENTS
The Mathematics House Since 1930
East Palestine, Ohio

HANDBOOK OF PRIVATE SCHOOLS
36th ed., 1264 pp., illus., red silk cloth, $8.00

The entire field of Private Education is described in this 1955 edition, —boarding and day schools, primary and secondary, preparatory and tutorial schools. These and other schools are presented with detailed data, descriptions of programs and facilities.

Listings of school memberships, associations, foundations, clinics, and vocational guidance agencies; a Who's Who of School Administrators; and new Finding Lists. New and up-to-date data for preparatory schools includes 1954 college entrance figures.

Used by executives and guidance officers everywhere as the source of information for the independent school field.

Junior Colleges and Specialized Schools and Colleges
2nd edition, 336 pp., cloth, $3.30; paper, $2.20

Indispensable in guidance work is this descriptive survey of junior colleges and schools of professional training throughout the country. Curricula, courses, enrollment, faculty, tuition, etc., are given for 600 junior colleges, 1100 specialized schools, and reference with names and addresses for 1200 colleges and universities.

PORTER SARGENT PUBLISHER
11 Beacon Street **Boston 8, Mass.**

STANDARDIZED TESTS
for
HIGH SCHOOL MATHEMATICS

IOWA ALGEBRA APTITUDE TEST

IOWA PLANE GEOMETRY APTITUDE TEST

LANE-GREENE UNIT TESTS IN PLANE GEOMETRY

LARSON-GREENE UNIT TESTS IN FIRST-YEAR ALGEBRA

All are revised quick-scoring editions

Write for catalog and prices

Bureau of Educational Research and Service
Extension Division, State University of Iowa, Iowa City

School Science *and* Mathematics

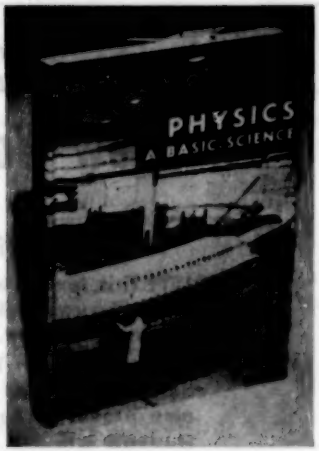
will keep you in touch with the most recent advances in scientific knowledge and teaching methods.

Classroom helps and special teaching devices for difficult topics are regular features. The Problem Department gives inspiration and extra activities for superior students.

The most progressive teachers in schools and colleges all over the world are regular readers and many of them are frequent contributors to this Journal.

School Science and Mathematics
P.O. Box 408, Oak Park, Ill.

Please Mention *School Science and Mathematics* when answering Advertisements



SCIENCE IN EVERYDAY LIFE

Obourn, Heiss, Montgomery

A stimulating new ninth year general science text that teaches basic principles through student participation in hundreds of learning activities. In solving 102 short learning problems about common scientific phenomena that affect their daily lives, students have opportunity to collect, organize, interpret, evaluate and apply information. They become familiar with scientific method while experiencing the thrill of personal discovery. Complete program includes *Workbook, Tests,* and *Teachers Guide.*

PHYSICS—A BASIC SCIENCE

Third Edition

Burns, Verwiebe, Hazel, Van Hooft

Completely revised and reset in 1954, this outstanding text approaches the unknown through the already familiar. Because basic physics principles are explained through everyday applications with which they have had experience, students meet each new topic with confidence. Moreover, each of the 83 short topics presents a single basic principle. The student is able to master one new learning at a time and to apply it immediately in practical situations. Over 1500 questions and almost 1000 problems at topic and chapter ends. Complete program includes combined *Laboratory Manual-Workbook, Unit Tests,* and *Teachers Guide.*

Mathematics for Everyday Living	***Leonhardy, Ely***
Earth Science—The World We Live In	***Namowitz, Stone***
Chemistry—A Course for High Schools *3rd Edition*	***Hogg, Alley Bickel***
Dynamic Plane Geometry **Dynamic Solid Geometry**	***Skolnik, Hartley***
Algebra in Easy Steps. ***Enlarged Edition***	***Stein***

D. VAN NOSTRAND COMPANY, INC.

120 Alexander Street **Princeton, New Jersey**

Have you seen the 1955 revision?

New World of Chemistry

BY BERNARD JAFFE

The 1955 revision is outstanding for:

CLARITY. This text is written in a forceful, easy-to-read style. The completely new format emphasizes what is most important.

BALANCE. More than 100 pages on theory give the student all he needs for future college work. The book also provides the practical applications which all students will use in everyday life.

FLEXIBILITY. Each topic is treated in a compact, independent chapter. These chapters may be "lifted out" and fitted into the teacher's individual teaching plan.

SILVER BURDETT COMPANY

MORRISTOWN, NEW JERSEY

NEW YORK • CHICAGO • SAN FRANCISCO • DALLAS • ATLANTA

A book that has a definite place wherever *functional* mathematics is taught or used . . .

MATHEMATICS AND MEASUREMENTS

by Merrill Rassweiler, *Associate Professor of Physical Science and Mathematics, The General College, University of Minnesota;* and J. Merle Harris, *Assistant Professor of Natural Sciences, The General College, University of Minnesota*

A program of fundamental mathematics for use in practical measurement situations . . .

. . . bridges the gap between traditional mathematics and the use of mathematics as a working tool

. . . focuses on the development of mathematical skills required in the laboratory, shop, and field

. . . provides extensive practice and experience in the application of basic mathematics principles to the solving of measurement problems.

This book is an outgrowth of a general education course successfully developed and taught by the authors to satisfy the needs of students who have *not* had any high school mathematics as well as for those who have.

Evanston Illinois — *Row Peterson and Company* — White Plains New York

NEW—EASY TO READ

General Science SMITH-JONES

. . . a new, 1955 science text for the 9th grade student with little or no science background. Those science facts and principles basic to the field of general science are given thorough and comprehensive coverage.

General Science Workbook SMITH-JONES

. . . a companion laboratory manual, activities and study guide to GENERAL SCIENCE. Eighty-one lesson-exercises and 191 pupil experiments compose this complete, up-to-date learning program.

J. B. LIPPINCOTT COMPANY

Chicago-Philadelphia-Atlanta-Dallas-Toronto

TEACH IN CHICAGO

SALARY SCHEDULE $3500 TO $6750 IN 12 STEPS
CREDIT FOR EXPERIENCE

FOR FULL INFORMATION WRITE
BOARD OF EXAMINERS
ROOM 242, 228 N. LA SALLE STREET, CHICAGO 1, ILLINOIS

SINCE 1931 **SCIENCE FILMSTRIPS** SINCE 1931
MADE BY TEACHERS FOR TEACHERS

BIOLOGY • HEALTH & SAFETY • PHYSICS • GENERAL SCIENCE
CHEMISTRY • MICROBIOLOGY

NEW—Elementary Science Series in Brilliant Spectracolor

Box 599SSM **VISUAL SCIENCES** Suffern, New York

THE EDUCATION OF YOUTH

America's Most Important Industry

New buildings must be equipped
Worn-out apparatus must be replaced
New type books must be used

TWO MILLION SALESMEN. Are they selling your goods?
FIFTY MILLION CUSTOMERS. Do they know your products?

The school population changes rapidly
To be effective advertising must be continuous
You are not addressing a mass meeting; it is a parade

SCHOOL SCIENCE AND MATHEMATICS

P.O. Box 408 Oak Park, Illinois

Please Mention School Science and Mathematics when answering Advertisements

NEW! EXCITING INSTRUCTIVE

"American Industry" EDUCATIONAL HOBBY KITS for boys and girls from 8 to 18

From some of the greatest scientific and educational sources of the country comes this most practical idea for the training of young America. Here are the actual materials, equipment and instructions to enable these young minds to delve into the mysteries of electronics, optics, medicine, weather, gemology . . . to explore . . . experiment . . . build . . . and experience the thrill of success.

Endorsed by leading educators . . . produced with the cooperation of such top ranking companies as Radio Corporation of America, American Optical Company, Gemological Institute of America and others . . . these Hobby Kits offer remarkable advantages when used by the individual student or for classroom instruction.

No. 71940 Electronics Kit enables one to conduct dozens of experiments with radio, sound waves, electrons . . . to build a radio receiver, a transmitter and other units. Complete set $29.95

No. 71945 Medical Kit contains instruments, supplies and instructions for emergency treatments, artificial respiration, treating a broken bone, etc. Complete set $19.95

No. 71950 Rock Detective Kit contains tools, specimens, magnifying glass, identification charts, and other equipment for identifying rocks and minerals. Complete set $14.95

No. 71955 Optical Kit contains materials, and equipment for making such things as telescopes, microscopes, periscopes; bending light rays and other experiments with light. Complete set $22.50

No. 71960 Weather Kit shows how to forecast weather. Includes a wide variety of materials and equipment plus a 48-page instruction book. Complete set $24.95

Order today or write for our Bulletin No. 300 which contains complete details.

cenco

The most complete line of scientific instruments and laboratory supplies in the world

S.S.C.

CENTRAL SCIENTIFIC COMPANY

MAIN OFFICE — PLANT — CENCO INTERNATIONAL CIA.
1718-L IRVING PARK ROAD • CHICAGO 13, ILLINOIS

BRANCHES AND OFFICES — CHICAGO NEWARK BOSTON
WASHINGTON DETROIT SAN FRANCISCO SANTA CLARA LOS ANGELES

CENTRAL SCIENTIFIC CO. OF CANADA, LTD. (and Hendry Division)
TORONTO MONTREAL VANCOUVER OTTAWA

REFINERY SUPPLY COMPANY — TULSA HOUSTON